Cumulative Impact Analysis

CHAPTER 5

CHAPTER 5. Cumulative Impact Analysis

SCOPE OF CUMULATIVE IMPACT ANALYSIS

This chapter analyzes the cumulative impacts of Reclamation's water contracting program. It contains three major sections. The first section analyzes cumulative impacts of water contracting alternatives within all three service areas, including Delta and Bay impacts. The next section summarizes historical perspectives on Central Valley, Delta, and Bay fishery, vegetation and wildlife resources, and identifies opportunities for Reclamation to mitigate for resource declines directly attributable to the CVP. The last section summarizes cumulative impacts of future related actions when added to the impacts of Reclamation's water contracting program.

CUMULATIVE IMPACTS OF WATER CONTRACTING IN ALL THREE SERVICE AREAS

Introduction

This section describes cumulative impacts of Reclamation's proposed water contracting actions, and alternatives, within all three service areas (SRSA, ARSA, and DESA). Two different types of cumulative impacts are assessed, depending on the environmental resource affected.

First, regional effects of Reclamation's water contracting alternatives are aggregated CVP-wide. This analysis is a geographic summation of regional impacts based on detailed regional impact analyses contained in each of the water contracting EIS's. The three water contracting EIS's should therefore be consulted for detailed descriptions of affected environments, regional impacts, and mitigation measures. Appendix VII presents tables from each EIS that summarize regional impacts within each source area

Second, for selected resources, cumulative impacts of water contracting within all three service areas on the Bay and Delta are analyzed. These resources, which were selected based on scoping process input, are surface water hydrology, surface water quality, fisheries, and vegetation and wildlife.

The cumulative impact analyses in this section addresses impacts of the No-Action Alternative and Alternative 1 through 7. Cumulative impacts of the Proposed Action within each service area are not specifically discussed because no modeling analyses were conducted for the Proposed Action. In general, impacts of the Proposed Action would be similar to those of Alternatives 1B and 2. The Final EIS will present a quantitative analysis of the Proposed Action's cumulative impacts based on additional model runs.

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Soils and Drainage

Based on regional impact analyses in each of the water contracting EISs, Reclamation's water contracting alternatives would not cause significant regional impacts on soil characteristics, including soil salinity, soil boron concentrations, and subsidence. Appendix VII summarizes soils and drainage impacts within each source area.

Surface Water Hydrology and Quality

Introduction

This discussion of cumulative impacts of supplying water to meet needs of requesting agencies in the SRSA, ARSA, and DESA discusses Delta inflow and outflow, reservoir storage levels, and Delta water quality. Impacts on flows in the Sacramento and American Rivers are described in Chapter 4 of those respective EISs, and summarized in Appendix VII.

Reclamation computer models were used to estimate reservoir storage levels and Delta flows based on water years 1922 through 1978, for current conditions and each water contracting alternative. Data tabulated for the following gauge locations are applicable to analyses described in this section: Folsom Reservoir storage, Shasta Reservoir storage, Clair Engle Reservoir storage, Delta inflow, and Delta outflow. Estimates of resulting Delta water quality were developed for the following D-1485 monitor stations: Chipps Island, Emmaton, Terminous, Antioch, Jersey Point, San Andreas, Mandeville Cut, Clifton Court Forebay, Tracy Pumping Plant, and Rock Slough (Contra Costa Canal Intake).

Each alternative has different effects on flow in the Delta and storage levels in Shasta, Clair Engle, and Folsom Reservoirs. To evaluate the cumulative impacts, analyses were made to simplify output from the models and allow a comparison between the alternatives.

Flow and Storage Variability. Average monthly and yearly flows for Delta inflow and outflow and average monthly and yearly storages in Shasta, Clair Engle, and Folsom Reservoirs were determined to identify variations among alternatives. These data were compared and plotted on a monthly basis for critically dry years, average of all 57 years, and wet years for current conditions and each of the alternatives. Results are shown on the following Appendix IV tables and figures.

	Appendix IV Table	Appendix IV Figures
Clair Engle Reservoir Storage	A	A and B
Shasta Reservoir Storage	B	C and D
Folsom Reservoir Storage	C	E and F
Delta Inflow	I	Q and R
Delta Outflow	J	S and T

Cumulative Effect. Reservoir storage and Delta flow levels affect fish, wildlife, recreation and economic resources discussed elsewhere in the EIS. In some instances, the impacts are opposing and tend to offset one another. Reservoir storage and Delta flows are in themselves opposing impacts because keeping the water in the reservoir results in less Delta flow and vice versa. Keeping water in one reservoir also affects levels in the other reservoirs because water must be released to meet the total needs. The cumulative effect is therefore a combination of the various impacts.

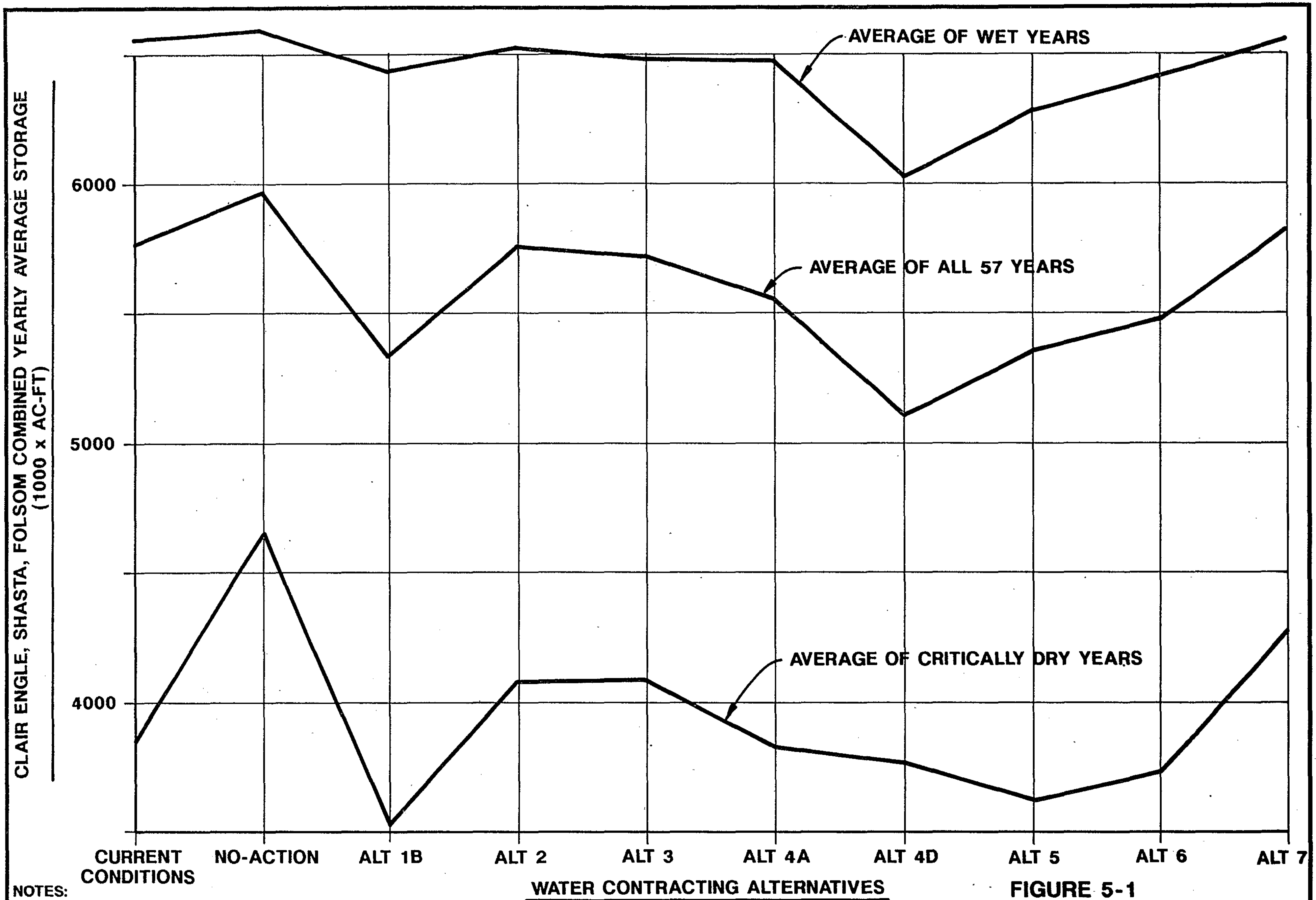
Surface Water Hydrology Comparisons

The discussion in this section focuses on comparisons between alternatives to provide a frame of reference for evaluation of impacts which may result from changes in reservoir levels and river flows. Appendix IV Tables A through J define changes to reservoir storage and river flows on monthly and annual bases. Graphical representation of these parameters, annual system storage and annual Delta inflow and outflow are shown in Figures 5-1 and 5-2.

It is difficult to display differences between one alternative and another by examining yearly averages of certain parameters. It is more difficult yet to understand the reasons for these differences. Many considerations are involved. From one alternative to another, inbasin (SRSA or ARSA) demands change, Delta exports change, and/or there are differences in operational criteria (i.e., instream flow objectives, frequency and magnitude of deficiencies). In general, differences will tend to be greater in drier years, when the CVP system is stressed, than in wetter years, when there is more than sufficient water to meet all needs. From a hydrologic standpoint, differences between alternatives of 5 percent or less are insignificant.

In general, a decline in the average system storage is expected if deliveries are increased over those of the No-Action Alternative. In addition, average annual Delta inflow decreases as the in-basin deliveries increase. Average annual Delta outflow follows the same trend as Delta inflow, and will be affected even more if Delta exports increase.

If, under an alternative, higher instream flows are an objective, Delta inflow may be higher in certain months than under the No-Action Alternative. To the extent that higher instream flow objectives cannot be used in the Delta to meet an outflow requirement or an export demand, average monthly Delta inflows increase. In the early fall months, when

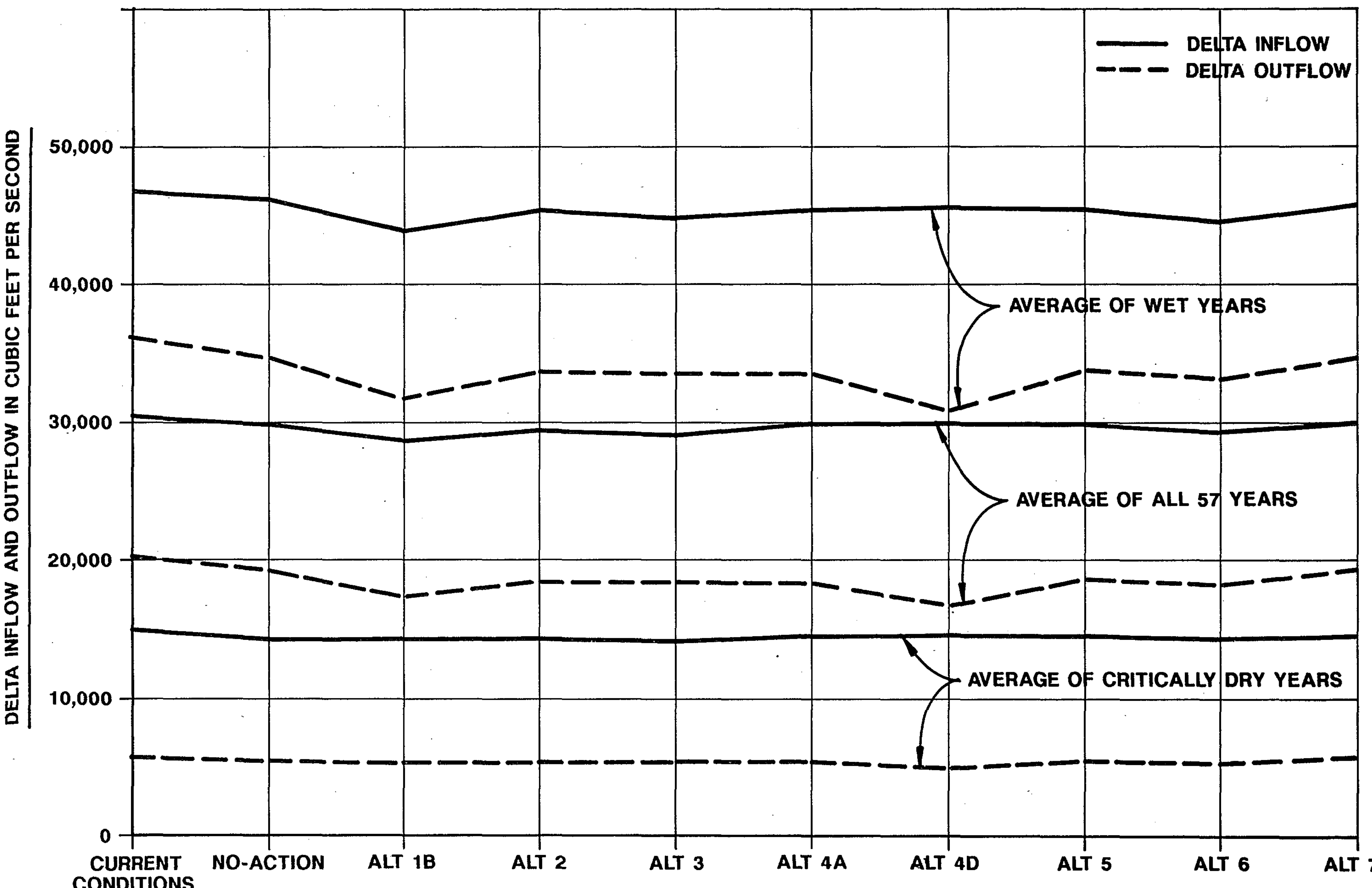


NOTES:

1. YEAR TYPES DEFINED BY SWRCB SACRAMENTO RIVER BASIN INDEX.
2. POINTS ARE CONECTED FOR ILLUSTRATION PURPOSES ONLY AND DO NOT DENOTE ANY RELATIONSHIP BETWEEN ALTERNATIVES.

FIGURE 5-1

COMBINED YEARLY AVERAGE STORAGE COMPARISON AMONG ALTERNATIVES



NOTES:

1. YEAR TYPES DEFINED BY SWRCB SACRAMENTO RIVER BASIN INDEX.
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FIGURE 5-2
DELTA INFLOW AND OUTFLOW COMPARISON AMONG ALTERNATIVES

C — 0 5 5 8 4 2

releases to evacuate flood control space are first being made, flood control releases would be correspondingly lower because the reservoirs would contain less water, and Delta inflow would be less. Similarly, for those alternatives with additional export demands, the monthly Delta inflow is higher during summer months. During the fall and winter months when reservoirs are refilling, flood control releases are not as large and average monthly Delta inflow generally decreases. To the extent that Delta surpluses can be utilized as a source for the increased export demand in a given month, Delta inflow does not increase.

No-Action Alternative. The No-Action Alternative comparisons are based on the change from current conditions. These are changes that will occur when full use of water under existing contracts takes place. As indicated in Figures 5-1 and 5-2, the average change from the current condition to the No-Action Alternative condition over the 57-year hydrologic period is small. On the average, system storage is about 4 percent higher and Delta inflow and outflow are about 2 percent lower.

The increase in system storage occurs for two reasons. First, they occur because of a change in deficiency criteria. In the 1985 level study, deficiencies were taken in only 4 years because deficiencies were keyed on low carry-over system storage; under the No-Action Alternative, deficiencies were taken in all critical years (8 years), regardless of carry-over system storage. Second, they occur because of a decrease in lower American River flow objectives under the No-Action Alternative. As a result of these changes, more water remains in the system reservoirs under the No-Action Alternative during critically dry years. The fish, wildlife, recreation, and economic conditions resulting from the storage and flow levels are also affected by these changes in operating assumptions.

Alternative 1A. Alternative 1A provides firm yield water deliveries to the same requestors as Alternative 2, with the remaining needs in the SRSA and the ARSA being met with intermittent water. As shown on Figures 5-1 and 5-2, the average change (using Alternative 2 and 3 as indicators) for the 57-year hydrologic period ranges from about 5 percent less reservoir storage to about 4 percent less Delta inflow and outflow. The reservoir storage changes are greater during critical dry years and less during wet years, and Delta flows are about the same or less than for the No-Action Alternative. This results because the total reservoir storage is being used during the critically dry years to develop the maximum CVP firm yield. Delta inflow decreases by about 2 percent under Alternative 1A and outflow decreases by about 5 percent. From a surface water hydrology viewpoint, these changes are less than significant and, in fact, reflect use of the reservoirs as they were authorized.

Alternative 1B. Alternative 1B provides firm yield water deliveries only to requestors with no economical groundwater alternative, with the remaining SRSA and ARSA needs being met with intermittent water. Under Alternative 1B, reservoir storage levels are about 10 percent less for the 57-year average than under the No-Action Alternative. Because the total deliveries under Alternative 1B are some 800,000 af/yr greater than under the No-Action Alternative, this decline in average system storage is expected. As shown in Tables A, B, and C in Appendix IV, storage levels are 10 percent higher in Clair Engle Reservoir and 30 percent lower in Folsom Reservoir. Such an operation maximizes the effectiveness of Folsom Reservoir in delivering firm and dependable supplies to the ARSA. Operational changes could have been made to decrease the draft on Folsom Reservoir for meeting Delta demands while increasing the draft on Clair Engle Reservoir.

Delta inflow and outflow decrease by 4 percent and 10 percent, respectively, under Alternative 1B. Much of the Delta export is made up of intermittent supplies, which flowed through the Delta as surplus under the No-Action Alternative. Delta outflow decreases by about 10 percent under Alternative 1B because many surplus flows, which under the No-Action Alternative became outflow, are exported at the state's Banks Pumping Plant.

Alternatives 2, 3, and 4A/B. Impacts of Alternatives 2 and 3 are the same as those described for Alternative 1A. Under Alternative 4A/B, the Alternative 2 deliveries are also made to the SRSA and ARSA. However, the model run and resulting values in Figures 5-1 and 5-2 do not reflect this allocation. The values for Alternative 2 and 3 are considered representative of the Alternative 4A/B impacts on the reservoirs and Delta flows.

Alternatives 4C/D and 5. No additional water is allocated to the SRSA and ARSA under these alternatives. The available yield is released from the reservoirs for Delta export or instream demands. This results in reservoir levels of about 15 percent less than the No-Action Alternative for the average of the 57 years. Delta inflow shows little change for these alternatives, but under Alternative 4C/D Delta outflow decreases by 13 percent.

Alternative 6. Under this alternative reservoir levels would be about 8 percent less than for the No-Action Alternative. Delta inflow and outflow decrease by about 2 percent and 6 percent, respectively, under this alternative.

Alternative 7. Under this alternative, reservoir storage and Delta inflow and outflow would change very little from the No-Action Alternative levels. The small change in reservoir storage and Delta inflow and outflow results from priorities of this alternative, i.e., keeping water in the reservoirs for recreation purposes and no additional water contracting.

Surface Water Quality Impacts

Appendix VII summarizes regional surface water quality impacts of Reclamation's water contracting alternatives on surface waters located within each of the three service areas. Cumulative impacts of the alternatives on Delta water quality are discussed below.

The Reclamation Fischer-Delta modeling study (see Technical Appendix B bound separately) uses steady-state salinities to identify and quantify impacts of the alternatives in the most direct manner possible. Model runs were used to identify the sensitivity of the Delta to changes in river flows resulting from the water contracting alternatives. Delta flows were evaluated over a wide range of water year types as well as seasons. Water years analyzed include 1934 (Critically Dry), 1954 (Above Normal), 1957 (Below Normal), and 1964 (Dry). Seasonal impacts were evaluated by using hydrology for the months of May and September. A wet year and the month of January were not evaluated because high salinities do not normally occur during high Delta outflows. In addition, the Fischer-Delta model was developed to predict ocean salinity intrusion during low Delta outflows and is not accurate at high outflows.

Data input to the Fischer-Delta model include Delta inflows, diversions at the state and federal export pumps, and Contra Costa Canal Intake, and seasonal Delta agricultural depletions and diversions. These data were obtained from Reclamation operation studies and DWR.

Results from the steady-state Fischer Delta model runs are compared to D-1485 M&I water quality standards for Rock Slough, Clifton Court Forebay, and Tracy Pumping Plant, and to D-1485 agricultural water quality standards for Emmaton, Jersey Point, Terminous, and San Andreas Landing. The D-1485 water quality standards used are shown in Table 5-1. In addition to the standards shown for Rock Slough, there is a more stringent standard that must be met for a number of days depending on the water year type. The Fischer Delta model was used for two steady-state cases of each water year type (to account for seasonal variation) because these are the critical months from a Delta water quality standpoint. However, because only 2 months are analyzed, it is not possible to determine if the Rock Slough more stringent standard was met on those days.

Results of the model study are summarized in Table 5-2. This table shows predicted steady-state salinities for the No-Action Alternative and Alternatives 2 through 7. Predicted steady-state salinities at the monitor stations are listed by the four water year types and the seasonal variation.

Although steady-state studies can be quite informative, results from this type of study must be used with caution. The assumption is that all inflows, diversions, agricultural returns, etc. are held constant for the duration of the model simulation. With these input values constant, velocities and water surface elevations throughout the Delta during a tidal day reproduce themselves after a simulation of several tidal days (when a repeating tide is used). However, a substantially longer period of time is required for salinity values to repeat themselves after a simulation of many tidal days. The period of time may be on the order of months whereas the hydrodynamics stabilize on the order of tidal days.

Model runs were not made for each water contracting alternative, but the seven alternatives evaluated are representative of impacts on Delta salinities. Results for Alternative 2 or 3 are considered applicable to Alternative 1A, and the Alternative 4A results are representative of Alternative 1B. (See Figure 5-2 for comparison of Delta inflow and outflow.) Deliveries of the Alternative 4 C/D water allocations would require cross-Delta facilities, and for this reason, Delta salinity impacts cannot be evaluated.

The D-1485 M&I standards shown in Table 5-1 were met by all alternatives modeled. Results show that the Rock Slough (Contra Costa Canal Intake) salinity levels for the No-Action Alternative were not exceeded by any of the other alternatives, including those providing for additional Delta exports. However, the model results indicate the D-1485 agricultural standards for Emmaton were not met for the May 1964 evaluation under the No-Action alternative and Alternatives 2, 3, 4A, and 6. The standard was exceeded by 111 ppm TDS for four of the alternatives and 143 ppm TDS for the fifth. The standard was not exceeded under Alternatives 5 and 7 because of the increase in Delta outflow over the other alternatives (because of no additional contracting). However, the annual Alternative 5 and 7 Delta inflows and outflows are essentially the same as for the No-Action Alternative. It is important to remember that the salinity values predicted by the model are

Table 5-1
D-1485 Delta Water Quality Standards

Municipal and Industrial

Rock Slough	250 mg/l Cl	738 mg/l TDS
Clifton Court Forebay	250 mg/l/Cl	795 mg/l TDS
Tracy pumping Plant	250 mg/l Cl	795 mg/l TDS

Agricultural (May)

	Emmaton		Jersey Point		Terminous		San Andreas Landing	
	mmhos EC	mg/l TDS	mmhos EC	mg/l TDS	mmhos EC	mg/l TDS	mmhos EC	mg/l TDS
Above Normal	0.45	290	0.45	281	0.45	[a]	0.45	[a]
Below Normal	0.45	290	0.45	281	0.45	[a]	0.45	[a]
Dry	0.45	290	0.45	281	0.45	[a]	0.45	[a]
Critical	2.78	1,520	2.20	1,195	0.54	[a]	0.87	[a]

[a] Not converted since other stations control

Table 5-2. Predicted Steady-State Salinities (ppm TDS) Using the Fischer Delta Model

Monitor Station	Water Year	Alt 1B		Alt 2		Alt 3		Alt 4A		Alt 5		Alt 6		Alt 7	
		May	Sep	May	Sep	May	Sep	May	Sep	May	Sep	May	Sep	May	Sep
11A Chipps	1934(C)	5,626	9,488	5,626	9,488	5,197	8,643	5,626	9,488	5,197	9,488	5,626	8,643	5,626	9,279
C Pittsbg	1934(C)	4,838	8,561	4,838	8,561	4,419	7,736	4,838	8,561	4,419	8,561	4,838	7,736	4,838	8,353
22 Emmaton	1934(C)	587	2,066	587	2,066	504	1,711	587	2,066	504	2,066	587	1,711	587	1,951
S Terminous	1934(C)	149	153	149	153	150	152	149	153	150	153	149	152	149	157
13 Antioch	1934(C)	2,002	4,356	2,002	4,356	1,752	3,737	2,002	4,356	1,752	4,356	2,002	3,737	2,002	4,210
15 Jersey	1934(C)	438	1,319	438	1,319	379	1,050	438	1,319	379	1,319	438	1,050	438	1,249
J Sandreas	1934(C)	174	415	174	415	163	336	174	415	163	415	174	336	174	394
18 Mndvl C	1934(C)	160	289	160	289	155	249	160	289	155	289	160	249	160	278
35 Clft Ct	1934(C)	266	441	266	441	260	407	266	441	260	441	266	407	266	426
R Dmc	1934(C)	328	458	328	458	323	432	328	458	323	458	328	432	328	447
O Rock Sl	1934(C)	269	624	269	624	249	518	269	624	249	624	269	518	269	588
11A Chipps	1954(AN)	561	6,419	664	6,419	686	5,738	719	4,998	686	6,419	719	4,663	561	6,419
C Pittsbg	1954(AN)	400	5,562	476	5,562	492	4,945	518	4,223	492	5,562	518	3,910	400	5,562
22 Emmaton	1954(AN)	127	688	128	688	129	568	128	441	129	688	128	394	127	688
S Terminous	1954(AN)	155	146	156	146	156	146	156	142	156	146	156	142	155	146
13 Antioch	1954(AN)	150	2,725	159	2,725	161	2,307	165	2,052	161	2,725	165	1,845	150	2,725
15 Jersey	1954(AN)	132	771	133	771	133	625	132	745	133	771	132	660	132	771
J Sandreas	1954(AN)	131	234	131	234	131	200	130	230	131	234	130	211	131	234
18 Mndvl C	1954(AN)	146	189	146	189	146	172	143	188	146	189	143	177	146	189
35 Clft Ct	1954(AN)	253	273	254	273	254	251	241	249	254	273	241	235	253	273
R Dmc	1954(AN)	326	327	326	327	326	309	320	302	326	327	320	291	326	327
O Rock Sl	1954(AN)	189	358	189	358	189	306	183	347	189	358	183	315	189	358
11A Chipps	1957(BN)	375	6,107	431	6,107	529	4,113	375	4,998	411	6,107	431	4,614	375	6,107
C Pittsbg	1957(BN)	270	5,266	307	5,266	379	3,423	270	4,223	294	5,266	307	3,864	270	5,266
22 Emmaton	1957(BN)	126	625	126	625	127	314	126	441	126	625	126	390	126	625
S Terminous	1957(BN)	165	143	165	143	167	142	165	142	165	143	165	141	165	143
13 Antioch	1957(BN)	139	2,594	142	2,594	149	1,402	139	2,052	141	2,594	142	1,825	139	2,594
15 Jersey	1957(BN)	132	774	132	774	132	379	132	745	132	774	132	664	132	774
J Sandreas	1957(BN)	132	233	132	233	133	155	132	230	132	233	132	313	132	233
18 Mndvl C	1957(BN)	146	189	146	189	146	146	146	188	146	189	146	178	146	189
35 Clft Ct	1957(BN)	227	262	229	262	229	203	227	249	228	262	229	233	227	262
R Dmc	1957(BN)	300	314	300	314	300	267	300	302	300	314	300	284	300	314
O Rock Sl	1957(BN)	184	358	184	358	184	220	184	347	184	358	184	317	184	358
11A Chipps	1964(D)	4,441	6,849	4,441	6,849	4,441	6,286	4,905	5,526	2,884	6,849	4,441	5,068	3,573	6,849
C Pittsbg	1964(D)	3,700	5,997	3,700	5,997	3,700	5,450	4,148	4,720	2,299	5,997	3,700	4,291	2,913	5,997
22 Emmaton	1964(D)	401	814	401	814	401	690	433	512	222	814	401	445	284	814
S Terminous	1964(D)	168	148	168	148	168	147	161	143	164	148	168	143	167	148
13 Antioch	1964(D)	1,302	2,846	1,302	2,846	1,302	2,495	1,674	2,309	656	2,846	1,302	2,021	911	2,846
15 Jersey	1964(D)	274	716	274	716	274	605	379	745	172	716	274	643	206	716
J Sandreas	1964(D)	152	227	152	227	152	203	162	226	139	227	152	206	143	227
18 Mndvl C	1964(D)	158	186	158	186	158	173	154	186	153	186	158	174	154	186
35 Clft Ct	1964(D)	266	273	266	273	266	256	237	249	256	273	266	232	259	273
R Dmc	1964(D)	307	313	307	313	307	298	293	300	296	313	307	286	302	313
O Rock Sl	1964(D)	234	348	234	348	234	307	241	348	207	348	234	310	216	348

C = Critically dry; AN = Above normal; BN = Below normal; D = Dry from steady-state runs and imply an ultimate value that may not be reached under dynamic conditions. A basic criterion of Reclamation's operations model is that sufficient Delta outflow would be provided to meet the D-1485 standards. Therefore, if additional outflow is needed to meet the Emmaton standards during a few days in May, additional water would be supplied for those days.

Mitigation Measures

Impacts on surface water hydrology and quality from implementation of the water contracting alternatives are not considered significant; therefore, no mitigation measures are proposed. Impacts on surface water hydrology and quality may, however, affect other resources. See discussions of cumulative impacts on fisheries, vegetation and wildlife, aesthetics, recreation, and cultural resources.

Groundwater

Appendix VII summarizes regional groundwater impacts of Reclamation's water contracting alternatives on groundwater basins located within each of the three service areas. Significant adverse regional impacts are not expected in any of the service areas.

Energy

This section describes the energy impacts in terms of reduced energy generation from CVP hydroelectric power plants due to water contracting and the energy savings from avoiding groundwater pumping. Most of the CVP power plants are immediately downstream from the storage reservoirs and are operated in conjunction with the water demands on these reservoirs. Thus, power generation is directly related to the irrigation, M&I, and other demands for CVP water.

An evaluation of power impacts was performed to estimate the power benefits of Reclamation's water contracting alternatives, including the No-Action Alternative. The evaluation calculated the project dependable capacity and the average annual generation for each alternative. These power benefits were each subtracted from the calculated power benefits of the No-Action Alternative. Negative net power benefits resulted for each water-contracting alternative. These negative net power benefits reflect a loss in power benefits, both capacity and generation, when compared to those of the No-Action Alternative. This loss is due to the reduced CVP reservoir storage levels available for power generation and to the increase in CVP power use for project water delivery purposes, resulting from the alternative water deliveries throughout the CVP service area. <u>Technical Appendix B</u> (bound separately) describes the power model runs used to estimate power generation.

No-Action Alternative

Under the No-Action Alternative, contractors who currently receive project power would continue to receive that power. The power model run for this alternative indicates the Project Dependable Capacity (PDC) would be 926 megawatts (MW), with an average annual generation of 3,600 gigawatt-hours (GWh). (See Table 5-12 in the "Economics" section of this chapter.) Energy used for groundwater pumping would be about 80 GWh in the SRSA, 400 GWh in the ARSA, and 500 GWh in the DESA.

Alternative 1 - Option A

Alternative 1 - Option A contractors who currently receive CVP power for conveyance, storage, and relift pumping were assumed to continue to receive power. Power was also supplied for conveyance and storage pumping for the refuges in the DESA.

The PDC would be 855 MW, with an average annual generation of 3,390 GWh (based on the average of results from the power model runs for Alternatives 3 and 4A/B). This would result in 210 GWh less average annual generation than from the No-Action Alternative. Energy savings from replacing groundwater pumping would be about 20 GWh in the SRSA, 270 GWh in the ARSA, and 100 GWh in the DESA.

Alternative 1 - Option B

Alternative 1 - Option B contractors who currently receive CVP power for conveyance, storage, and relift pumping were assumed to continue to receive power. Power was also supplied for conveyance and storage pumping for the refuges in the DESA.

The power model run for this alternative indicates the PDC would be 779 MW, with an average annual generation of 3,180 GWh. This would result in 420 GWh less average annual generation than from the No-Action Alternative. Energy savings from replacing groundwater pumping would be about 20 GWh in the SRSA, 270 GWh in the ARSA, and 80 GWh in the DESA.

Alternative 2

Under Alternative 2, CVP power was used for additional water deliveries through the Tehama-Colusa Canal. Water exported to the DESA was assumed to receive CVP power for conveyance, storage, and relift pumping.

The power model run for this alternative indicates the PDC would be 848 MW, with an average annual generation of 3,390 GWh. This would result in 210 GWh less average annual generation than from the No-Action Alterative. Energy savings from replacing groundwater pumping would be 10 GWh in the SRSA, 110 GWh in the ARSA, and 50 GWh in the DESA.

Alternative 3

Under Alternative, 3 CVP power was used for additional deliveries through the Tehama-Colusa Canal. Although the power model run did not include deliveries to the DESA, Alternative 3 now includes water exported to the DESA and CVP power would be used for conveyance, storage, and relief pumping.

Adjustments of the power model run output for this alternative to include deliveries to the DESA indicates the PDC would be 890 MW, with an average annual generation of 3,550 GWh. This would result in 50 GWh less average annual generation than from the No-Action Alternative. Energy savings from replacing groundwater pumping would be about 10 GWh in the SRSA, 270 GWh in the ARSA, and 60 GWh in the DESA.

Alternative 4A/B

The power model run for Alternative 4A/B did not include CVP power for additional water deliveries through the TCC, although that would be required under the current water allocation for this alternative. Additional water exported to the DESA received power for conveyance and some relift pumping.

Adjustment of the power model run output to include deliveries through the TCC indicates the PDC would be 820 MW, with an average annual generation of 3,240 GWh. This would result in 360 GWh less average annual generation than from the No-Action Alternative. Energy savings from replacing groundwater pumping would be about 10 GWh in the SRSA, 110 GWh in the ARSA, and 140 GWh in the DESA under 4A and 160 GWh under 4B.

Alternative 4C/D

Under Alternative 4C/D, any time water and excess conveyance capacity were available in the Delta, water was pumped to offstream storage south of the Delta. Those receiving additional water received CVP power for conveyance and storage pumping, but not for relifting.

The power model run for this alternative indicates the PDC would be 759 MW, with an average annual generation of 2,810 GWh. This would result in 790 GWh less average annual generation than from the No-Action Alternative. There would be no energy savings from replacing groundwater pumping in the SRSA or ARSA, but 310 GWh would be saved in the DESA under 4C and 250 GWh under 4D.

Alternative 5

Under Alternative 5, CVP power was not supplied for deliveries to refuges in the SRSA. Project power for refuge water delivered in the DESA was supplied for conveyance and storage pumping.

The power model run for this alternative indicates the PDC would be 870 MW, with an average annual generation of 3,500 GWh. This would result in 100 GWh less average annual generation than from the No-Action Alternative. There would be no energy savings from replacing groundwater pumping in the SRSA or ARSA, but 10 GWh would be saved in the DESA.

Alternative 6

Under Alternative 6, CVP power was used for additional water deliveries through the Tehama-Colusa Canal. Water exported to DESA current contractors received power for conveyance, storage, and relift pumping. Project power for refuge water delivered to the DESA was supplied for conveyance and storage pumping.

The power model run for this alternative indicates the PDC would be 815 MW, with an average annual generation of 3,290 GWh. This would result in 310 GWh less average annual generation than from the No-Action Alternative. Energy savings from replacing groundwater pumping would be about 10 GWh in the SRSA, 110 GWh in the ARSA, and 120 GWh in the DESA.

Alternative 7

The power model run for this alternative indicates the PDC would be 924 MW, with an average annual generation of 3,580 GWh. This would result in 20 GWh less average annual generation than from the No-Action Alternative. There would be no energy savings from replacing groundwater pumping in the SRSA or DESA, but 10 GWh would be saved in the DESA.

Fisheries

The "Fisheries" section of Chapter 4 of the ARWC, SRWC, and DEWC EIS's presents impacts and mitigation measures for each service area. This section combines impacts occurring in all three service areas described in each EIS, and adds impacts resulting from changes in environmental conditions outside the individual service areas, and impacts not directly attributable to any one service area. The primary focus is on Delta and Bay fisheries impacts, since detailed analyses of reservoir and river fisheries are presented in Chapter 4 of each of the EIS's and summarized in Appendix VII.

Delta and Bay Impacts

Methods. Existing fisheries conditions in the Delta and Bay are described in Appendix VIII. CVP storage and diversion facilities affect the Delta and Bay fisheries environment by controlling the timing, frequency, and duration of water volume or water quality conditions. Fish population impacts (i.e., changes in abundance, distribution, or production) will depend primarily on the response of individuals (survival, growth, reproduction, or migration) to changes in environmental conditions. This impact analysis focuses on species for which responses to specific environmental conditions have been determined, although for most species these responses are qualitative. Several indices (corresponding to environmental changes) were developed to show the relative degree of impact to fish populations. These indices are discussed below; a detailed discussion of index development methodology is presented in Technical Appendix D.

The operations, power, and water quality models (described in Technical Appendix C) provided information on river discharge, Delta flow patterns, water quality, diversion rates, and Delta outflow. The models are not assumed to represent actual conditions but are assumed to produce information indicative of the relative changes that result under alternative operations. General changes were described in the "Surface Water Hydrology and Seepage" and "Surface Water Quality" sections. Discharge and diversion ratios are the primary affected environmental conditions analyzed in relation to Delta and Bay fish population impacts.

The impact analyses below are subject to a number of limitations. Delta hydrology for the impact indices described below was modeled only for May and September of 4 years ("Surface Water Hydrology and Seepage" section). Impacts for other months were interpolated from export-river discharge relationships. Also, water use (diversions) under some of the alternatives was significantly greater than that included in the model. Adjustments to impacts were made on a case-by-case basis.

Discharge Effects on Chinook Salmon. Discharge affects temperature, water quality, velocity, water surface elevation, food availability, habitat area, diversion ratio, and other environmental conditions. Although information is generally lacking on the precise relationships between discharge and most environmental conditions and between environmental conditions and impacts on fish populations, Sacramento River discharge during May and June has been correlated with chinook salmon smolt survival. Recent information has shown that temperature blurs the relationship, with lower temperatures increasing survival at all discharges, but the relationship still appears to hold.

A Sacramento River flow index is used to determine the effects of change in Sacramento River discharge on chinook salmon survival. The index is a relative measure (i.e., an index value of 1.00 means that survival is 100 times greater than at an index value of 0.00). Survival is highest above 27,000 cfs (index value equals 1.00) and lowest below 12,000 cfs (index value equals 0.00).

Diversion Effects on Chinook Salmon and Steelhead Trout. Delta diversions impact salmon and steelhead through entrainment and entrapment. Fish are entrained in water moving toward diversions, which delays movement along a natural path or moves fish into alternate paths. Entrained fish eventually move out of the influence of entrainment or are entrapped by agricultural and municipal diversions, including hundreds of small diverters and the CVP and SWP pumps. The diversion impact on a fish population depends on diversion timing and volume, river discharge, species, lifestage, diverted water destination, screening efficiency, and other factors.

Diversion indices were developed for Sacramento River chinook salmon and steelhead trout and San Joaquin River chinook salmon. During chinook salmon and steelhead trout outmigration, juveniles are assumed to be diverted from the river or channel in the same proportion as the water (i.e., diversion volume divided by river discharge). Survival decreases with the migration delay caused by each diversion, due to increased exposure to additional environmental hazards (i.e., predation, adverse temperatures, exposure to toxins). Steelhead trout are affected in March and April; Sacramento River chinook salmon are affected primarily in April, May, and June; and San Joaquin chinook salmon are affected in March, April, and May.

The Sacramento River diversion index is based on the proportion of water diverted across the Delta through the Delta Cross Channel and Georgiana Slough and the proportion of this water diverted toward the CVP and SWP pumps via the Old and Middle Rivers. The San Joaquin River diversion index is based on the proportion of water diverted at the Old River near Mossdale and the proportion diverted at the Old and Middle Rivers in the central Delta after the San Joaquin River mixes with Sacramento River water. Increasing the proportions that are diverted lowers the indices, which indicates lower survival and greater impacts on chinook salmon. The level of impacts also depends on the timing of the diversion in relation to the temporal distribution of juvenile chinook salmon and steelhead trout populations.

An important factor affecting juvenile chinook salmon and steelhead trout survival at the CVP pumps is screening efficiency. Although the screens are believed to be nearly 100 percent efficient for both species, increased export would change the efficiency. Information is not available to determine the change in efficiency.

Diversion Effects on Striped Bass. Diversion effects for striped bass include those described for chinook salmon; however, the effects on striped bass are much greater due to differences in life history and they continue over an extended period. Striped bass are most vulnerable to diversion impacts from April through mid-July, but impacts continue to varying degrees throughout the year.

A striped bass diversion index was developed for spawning in the Sacramento River and the Delta. Striped bass eggs, larvae, and juveniles are assumed to be diverted from the river or channel in the same proportion as the water (i.e., diversion volume divided by river discharge). Survival decreases with retention in the central Delta due to increased exposure to additional environmental hazards (i.e., predation, exposure to toxins, exposure to diversions, decreased food availability).

The diversion index incorporates Sacramento River and Delta progeny. The proportion of water diverted across the Delta through the Delta Cross Channel and Georgiana Slough, and the proportion of Sacramento River water moving up the lower San Joaquin River affect Sacramento River progeny. The proportion of water diverted toward the CVP and SWP pumps via the Old and Middle Rivers affects the Sacramento River and Delta progeny. Increasing the proportions that are diverted lowers the indices, which indicates lower survival and greater impacts on striped bass. The level of impacts depends on the timing of the diversion in relation to temporal striped bass distribution. The index was determined for April through August.

Screening efficiency at the CVP pumps determines salvage rates of juvenile striped bass. Increased export would change the efficiency, but information is not available to determine the change in efficiency based on increased export.

Discharge Effects on American Shad. Delta inflow during April, May, and June has been correlated with young-of-the-year American shad abundance in the fall. An American shad relative abundance index was used to determine the effects of Delta inflow change on young-of-the-year abundance. As with the chinook salmon flow index, the shad abundance index is a relative measure. Average Delta inflows for April, May, and June exceeding 65,000 cfs (index value equals 1.00) result in the highest abundance and inflows less than 5,000 cfs (index value equals 0.07) result in the lowest abundance.

Diversion Effects on American Shad. American shad are affected by diversions during two periods. Eggs, larvae, and juveniles of the Delta and lower river spawning are sensitive to June, July, and August diversions and the effects are similar to those described for striped bass. Juveniles of the Sacramento River spawning are sensitive to October, November, and December diversions and the effects are similar to those described for chinook salmon. The diversion indices used for chinook salmon and striped bass are determined for the months applicable to American shad. The greater the proportion diverted, the greater the impact on juvenile shad survival.

Screening efficiency at the CVP pumps determines salvage rates of juvenile American shad. Increased export would change the efficiency, but information is not available to determine the change in efficiency based on increased export.

Delta Outflow Effects on Neomysis. Neomysis are an important prey item in the diet of chinook salmon, striped bass, American shad, and many other species. Neomysis are most abundant in the entrapment zone and movement of the entrapment zone into the Delta reduces the available habitat area and phytoplankton concentration (a major food for Neomysis). At the upstream edge of the entrapment zone is the null zone. Delta outflows of less than 4,000 cfs move the null zone toward the Delta. As an indication of impacts to Neomysis production, the frequency of Delta outflows of less than 4,000 cfs during a month for the 56-year period of record was determined.

Other effects would also result from operational changes of CVP-related facilities. Increased export would increase flow velocities in Delta channels, worsening conditions (i.e., increased scour, reduced residence times) for planktonic and benthic organism production. Also, Sacramento River water is deficient in zooplankton compared to central Delta waters. Central Delta water is replaced with the zooplankton-deficient water during high export, which reduces food availability for some species. Increased export would probably entrap more white catfish, threadfin shad, and other species.

Delta outflow would be reduced, influencing Bay mixing patterns and flushing characteristics. Reduced flushing rates could increase toxic concentrations under current waste disposal practices, increasing deleterious effects on fish populations. Species distribution would be altered by changes in salinity and recruitment would be reduced for those species dependent on estuarine circulation for larval transport.

The significance of these and other environmental changes and the levels of impacts to species populations cannot be quantitatively determined with available information, but qualitative determinations can be made. To provide a better understanding of the complex physical and biological aspects of the Delta-Bay system, further studies are needed.

Determination of Significance. In all cases, a 10-percent detrimental change in the measured variable (whether the variable is an index, frequency, or discharge) is considered indicative of a significant impact. The 10-percent level is believed to be sufficient to indicate actual changes and not model data aberrations. Actual changes in fish population abundance, distribution, or production, however, may not be reflected in the relative changes of the indices because of the inherent complexity and uncertainty involved with ecosystem modification. Tables supporting the impact conclusions described below are presented in Appendix IX.

No-Action Alternative. Sacramento River chinook salmon migrant survival would not be affected by changes in Sacramento River discharge under the No-Action Alternative as compared to 1985 conditions. The Sacramento River flow index was 0.5 in May and 0.4 in June under both operations conditions. Migrant survival, however, would be adversely affected by increased SWP export and upstream diversion during April, May, and June of most years (Appendix IX, Tables A and B). Also, Sacramento migrant juvenile steelhead trout survival would also be adversely affected by increased export and upstream diversion during March and April.

San Joaquin River juvenile chinook salmon survival would be adversely affected by the increased SWP export and upstream diversions under the No-Action Alternative as compared to 1985 conditions during below-normal and wetter year types (Appendix IX, Tables C and D). Survival during dry and critically dry year types would not change under the No-Action Alternative as compared to 1985 conditions.

Striped bass survival would be adversely affected by increased export and upstream diversions during most months of most years by the changes under the No-Action Alternative (Appendix IX, Tables E and B). American shad juvenile abundance would also be adversely affected by the increase in the proportion diverted, but fall young-of-the-year abundance would not change due to Delta inflow changes that would occur under the No-Action Alternative. The relative abundance index value would be 0.32 for both 1985 conditions and the No-Action Alternative.

Neomysis production would be adversely affected by the decrease in Delta outflow. The frequency of Delta outflows of less than 4,000 cfs increases during July and August, major months for Neomysis production (Appendix IX, Table F).

Export would increase during most months of most years (Appendix IX, Table G) under the No-Action Alternative as compared to 1985 conditions due to increased SWP exports. The increase in export would be expected to adversely affect food production and availability and to increase the entrapment of all fish species. The decrease in food availability and increased entrapment would adversely impact migratory and resident fish in the Delta.

Delta outflow decreases would occur most often during fall and winter, although decreases would also occur during other months, depending on year type (see "Surface Water Hydrology and Seepage" section). Outflow decreases would reduce Bay flushing rates, increase salinity for San Pablo and Suisun Bays during some months, and reduce the intensity of estuarine circulation. Striped bass and other species sensitive to toxins entering the Bay may be adversely affected. Estuarine species may be adversely affected by a decrease in habitat area due to increased salinity, but marine species may benefit from the increase in habitat area. Recruitment of species dependent on estuarine circulation transport of larvae may be adversely affected.

Alternative 1 - Option A. Sacramento River juvenile chinook salmon would not be significantly impacted by decreases in Sacramento River discharge as compared to the No-Action Alternative. Discharge decreases under Alternative 1 - Option A would fall somewhere between decreases determined for Alternatives 2 and 3, with conditions identical to Alternative 2 during critically dry years and identical to Alternative 3 during wet years (Appendix IX, Table H).

Sacramento River chinook salmon also would not be significantly impacted by increased upstream diversions and export. The Sacramento River diversion indices for Alternatives 2 and 3 are used as explained above, with additional adjustment for diverted water that was not included in the model output (Appendix IX, Tables I and J). Actual indices would closely resemble those for Alternative 1 - Option B in wetter years. Steelhead also would be significantly impacted.

San Joaquin River chinook salmon would not be significantly impacted by the changes under Alternative 1 - Option A. As above, the indices for Alternatives 2 and 3 were used, with some adjustment for increased diversions that were not reflected in the model output (Appendix IX, Tables K and L).

Striped bass egg, larvae, and juvenile survival would not be significantly impacted by the changes that would occur under Alternative 1 - Option A. The indices for Alternatives 2 and 3 were used as above (Appendix IX, Tables M and J).

Juvenile American shad relative abundance would not be significantly impacted by April, May, and June Delta inflow decreases (Appendix IX, Table N). Diversion and export increases would not have a significant impact on American shad juveniles during June, July, and August, but significant increases over the No-Action Alternative during October and November would significantly impact the outmigrant juvenile shad (Appendix IX, Table J).

The frequency of less-than-4,000-cfs Delta outflows would be nearly the same for the No-Action Alternative and Alternative 1 - Option A. Therefore, Neomysis production would probably not be significantly impacted (Appendix IX, Table O).

Although the model output showed little change in export for Alternatives 2 and 3, actual export will approach the changes shown for Alternative 1 - Option B (Appendix IX, Table P). The decline in food production and availability and increased entrapment at the CVP pumps would probably significantly impact resident and migratory species in the Delta.

Reductions in Delta outflows would occur under Alternative 1 - Option A, except during July, August and September. Bay species (including striped bass, English sole, and others) could be significantly impacted by reduced flushing rates, increased salinity in San Pablo and Suisun Bays, and reduced estuarine circulation intensity.

Alternative 1 - Option B. Sacramento River juvenile chinook salmon would be significantly impacted by decreases in Sacramento River discharge during May and June as compared to discharge that would occur under the No-Action Alternative (Appendix IX, Table H). Sacramento River chinook salmon and steelhead trout, and San Joaquin River chinook salmon would not be significantly impacted by increased upstream diversions and export (Appendix IX, Tables I, J, K, and L).

Striped bass egg, larvae, and juvenile survival would not be significantly impacted by the changes in diversions that would occur during April through July of most year types (Appendix IX, Tables M and J). Juveniles would be significantly impacted during August by increased upstream diversions and export that would occur under Alternative 1 - Option B.

Juvenile American shad relative abundance would not be significantly impacted by April, May, and June Delta inflow decreases (Appendix IX, Table N). Diversion and export increases would significantly impact American shad juveniles, primarily during August, October, and November (Appendix IX, Table J).

The frequency of less-than-4,000-cfs Delta outflows would be nearly the same for the No-Action Alternative 1 and Alternative 1 - Option B. Therefore, Neomysis production would probably not be impacted (Appendix IX, Table P).

Alternative 1 - Option B would result in increases in export during the summer months (Appendix IX, Table Q). The decline in food production and availability and the increased entrapment at the CVP pumps would probably significantly impact resident and migratory species in the Delta.

Reductions in Delta outflow would occur under Alternative 1 - Option B, except during July, August, and September. Bay species (including striped bass, English sole, and others) may be impacted by reduced flushing rates, increased salinity in San Pablo and Suisun Bays, and reduced estuarine circulation intensity.

Alternative 2. Sacramento River juvenile chinook salmon would not be significantly impacted by decreases in Sacramento River discharge as compared to the No-Action Alternative (Appendix IX, Table H). They also would not be significantly impacted by increased upstream diversions and export (Appendix IX, Tables I and J). Steelhead trout also would not significantly impacted.

San Joaquin River chinook salmon would not be impacted by changes in diversions and cross-Delta flows under Alternative 2 (Appendix IX, Tables K and L). Striped bass egg, larvae, and juvenile survival also would not be significantly impacted by diversions or cross-Delta flows (Appendix IX, Tables N and J).

Juvenile American shad relative abundance would not be significantly impacted by April, May, and June Delta inflow decreases (Appendix IX, Table N). Diversion and export increases would not significantly impact American shad juveniles, and the largest impacts would occur during October of below-normal and drier water year types (Appendix IX, Table J).

The frequency of less-than-4,000-cfs Delta outflows would be nearly the same for the No-Action Alternative and Alternative 2. Therefore, Neomysis production would probably not be impacted (Appendix IX, Table O).

Export for Alternative 2 would change for only a few months as compared to the No-Action Alternative (Appendix IX, Table P). The changes in food production and availability and the increased entrapment at the CVP pumps would probably not significantly impact resident and migratory species in the Delta.

Reductions in Delta outflow under Alternative 2 would be similar to those under Alternative 1 - Option A but not as severe. The impacts would be similar but less intense.

Alternative 3. Sacramento River juvenile chinook salmon would be significantly impacted by decreases in Sacramento River discharge during May and June as compared to discharges that would occur under the No-Action Alternative (Appendix IX, Table H). The index values estimated from model output indicate no change, but actual upstream diversions for the alternative would approach those of Alternative 1 - Option B. Other fisheries impacts would be the same as described for Alternative 1 - Option B.

Alternative 4A/B. Sacramento River juvenile chinook salmon would not be significantly impacted by decreases in Sacramento River discharge (Appendix IX, Table H). Increased upstream diversions and export would not significantly impact Sacramento River chinook salmon and steelhead (Appendix IX, Tables I and J). Increased export would not significantly impact San Joaquin River chinook salmon (Appendix IX, Tables K and L).

Striped bass would probably be significantly impacted by the Delta hydrology changes caused by increased upstream diversions and export. The indices determined from model output indicate significant changes during some months of some years (Appendix IX, Tables J and M). Actual export would be greater and Sacramento River discharge less, causing greater differences between the No-Action Alternative and Alternative 4A/B than that depicted by the model.

Juvenile American shad abundance would not be significantly impacted by the inflow conditions under Alternative 4A/B as compared to the No-Action Alternative (Appendix IX, Table N). Delta hydrology changes caused by increased upstream diversions and exports would significantly impact juvenile shad abundance, primarily during the summer months and to a lesser degree during the fall months (Appendix IX, Table J).

Although the frequency of less-than-4,000-cfs Delta outflows would be reduced under Alternative 4A/B, as compared to the No-Action Alternative (Appendix IX, Table O), actual frequencies would be much higher because more water would be diverted than was depicted by the model. Neomysis production, however, would probably not be impacted.

Alternative 4A/B would result in changes in export during the summer months (Appendix IX, Table P). The decline in food production and availability and the increased entrapment at the CVP pumps would probably have a significant impact on resident and migratory species in the Delta.

Reductions in Delta outflows would occur under Alternative 4A/B, except during July, August, and September. Bay species (including striped bass, English sole, and others) may be significantly impacted by reduced flushing rates, increased salinity in San Pablo and Suisun Bays, and reduced estuarine circulation intensity.

Alternative 4C/D. Because this alternative would require major changes in current Delta water transport conditions, fisheries impacts can not be analyzed based on current transport conditions.

Alternative 5. Sacramento River juvenile chinook salmon would be significantly impacted by decreases in Sacramento River discharge during May but not significantly impacted in June (Appendix IX, Table H). Delta conditions resulting from upstream diversions and export under Alternative 5 would probably benefit Sacramento River chinook salmon and steelhead, and San Joaquin River chinook salmon, striped bass, and American shad (Appendix IX, Tables I, J, K, L, and M). Delta inflow that would occur under Alternative 5 would not impact juvenile American shad abundance (Appendix IX, Table N).

The frequency of less-than-4,000-cfs Delta outflows would increase under Alternative 5 as compared to the No-Action Alternative (Appendix IX, Table O). Neomysis production would probably be significantly impacted during late summer, primarily during August.

Alternative 5 would result in no change in export and would not impact food production and availability or increase entrapment (Appendix IX, Table O). Operation under Alternative 5 would redistribute and reduce outflow, but Bay species (including striped bass, English sole, and others) would probably not be significantly impacted by any environmental changes as compared to the No-Action Alternative.

Alternative 6. Impacts for Alternative 6 would be the same as impacts for Alternative 4A/B after adjusting for increases in upstream diversions and export not depicted in the indices estimated from model output.

Alternative 7. Alternative 7 would have no additional impacts as compared to the No-Action Alternative.

Impact Summary for All Three Service Areas, Delta and Bay

Environmental changes that would impact chinook salmon are primarily riverine and within Delta. The most significant riverine impacts are deleterious temperature effects on spawning and rearing success (Table 5-3). Alternative 1 - Options A and B, and Alternatives 3 and 4C/D would have the greatest significant impacts. Alternatives 5 and 7 would probably not significantly impact chinook salmon as compared with the No-Action Alternative.

Table 5-3. Impact Summary for All Three Service Areas, Including Delta and Bay Impacts

Species / Area / Environmental Change	Alternatives 1A	1B	2	3	4A/B	4C/D	5	6	7
Chinook Salmon									
American River									
Spawning temperature	N	B	N	N	N	B	N	N	N
Spawning discharge	N	N	N	N	N	N	B	N	N
Rearing temperature	N	B	N	N	N	B	N	N	N
Rearing discharge	N	N	N	B	N	N	S	N	N
Sacramento River									
Spawning temperature	S	S	N	S	N	S	N	S	N
Spawning discharge	N	N	N	N	N	N	B	N	N
Rearing temperature	N	S	N	N	N	S	N	N	N
Rearing discharge	N	N	N	N	N	N	B	N	N
Diversion entrainment	N	N	N	N	N	N	N	N	N
Trinity River									
Temperature	N	N	N	N	N	N	N	N	N
Discharge	N	N	N	N	N	N	N	N	N
San Joaquin River	N	N	N	N	N	N	N	N	N
Delta and Bay									
Migration discharge	N	S	N	S	N	N/A	N	N	N
Diversion and export									
Sacramento River	N	N	N	N	N	N/A	B	N	N
San Joaquin River	N	N	N	N	N	N/A	B	N	N
Delta outflow	N	N	N	N	N	N/A	N	N	N
Steelhead Trout									
American River	N	N	N	N	N	N	N	N	N
Sacramento River									
Spawning temperature	N	N	N	N	N	N	N	N	N
Rearing temperature	N	S	N	N	N	S	N	N	N
Diversion entrainment	N	N	N	N	N	N	N	N	N
San Joaquin River	N	N	N	N	N	N	N	N	N
Delta and Bay									
Diversion and export	N	N	N	N	N	N/A	B	N	N
Striped Bass									
American River	N	N	N	N	N	N	N	N	N
Sacramento River	N	N	N	N	N	N	N	N	N
San Joaquin River	N	N	N	N	N	N	N	N	N
Delta and Bay									
Diversion and export									
Direct	N	N	N	N	S	N/A	B	S	N
Indirect	S	S	N	S	S	N/A	N	S	N
Delta outflow	S	S	S	S	S	N/A	N	S	N

Table 5-3. Continued

Species Area Environmental Change	1A	1B	2	3	4A/B	4C/D	5	6	7
American Shad									
American River									
Spawning temperature	N	N	N	N	N	N	N	N	N
Spawning discharge	N	S	N	N	N	N	N	N	N
Sacramento River	N	N	N	N	N	N	N	N	N
San Joaquin River	N	N	N	N	N	N	N	N	N
Delta and Bay									
Spawning discharge	N	N	N	N	N	N/A	N	N	N
Diversion and export									
Direct	S	S	N	S	S	N/A	B	S	N
Indirect	S	S	N	S	S	N/A	N	S	N
Delta outflow	N	N	N	N	N	N/A	N	N	N
Other Species									
American River									
General	N	N	N	N	N	N	N	N	N
Sacramento River									
General	N	N	N	N	N	N	N	N	N
San Joaquin River	N	N	N	N	N	N	N	N	N
Delta and Bay									
Diversion and export									
Direct	N	N	N	N	N	N/A	N	N	N
Indirect	S	S	N	S	N	N/A	N	S	N
Delta outflow	S	S	S	S	S	N/A	N	S	N
Special-Status Species									
Winter-Run Chinook Salmon									
Sacramento River									
Spawning temperature	N	S	N	N	N	S	S	S	S
Spawning discharge	N	N	N	N	N	N	B	N	N
Rearing temperature	N	S	N	N	N	S	N	N	N
Rearing discharge	N	N	N	N	N	N	B	N	N
Diversion entrainment	N	N	N	N	N	N	N	N	N
Delta and Bay									
Diversion and export	N	N	N	N	N	N/A	N	N	N
Delta outflow	N	N	N	N	N	N/A	N	N	N
Delta Smelt									
Delta and Bay									
Diversion and export									
Direct	N	N	N	N	N	N/A	N	N	N
Indirect	S	S	N	S	S	N/A	N	S	N
Delta outflow	S	S	S	S	S	N/A	N	S	N
Sacramento Splittail									
Delta and Bay									
Diversion and export									
Direct	N	N	N	N	N	N/A	N	N	N
Indirect	S	S	N	S	S	N/A	N	S	N
Delta outflow	S	S	S	S	S	N/A	N	S	N

Table 5-3. Continued

Species Area Environmental Change	1A	1B	2	3	4A/B	4C/D	5	6	7
	Alternatives								
Reservoir Species									
Folsom									
Water surface area	N	S	N	S	N	S	S	S	S
Water surface elevation	S	S	S	S	S	S	S	S	S
Shasta									
Water surface area	N	N	N	N	N	S	N	N	N
Water surface elevation	N	N	N	N	N	S	N	N	N
Clair Engle									
Water surface area	N	N	N	N	N	S	N	N	N
Water surface elevation	N	N	N	N	N	S	N	N	N

Note: N = Not significant.
S = Significant.
B = Beneficial.
N/A = Not available.

The most significant effects within the Delta would be reduced inflow and cross-Delta flow of water from the Sacramento River toward the SWP and CVP pumps. The primary impact to chinook salmon is entrainment and the subsequent delay in migration and increased exposure to factors that decrease survival. Alternative 1 - Option B and Alternative 3 would have the greatest significant impacts (Table 5-3). Alternatives 5 and 7 either would cause less-than-significant impacts or would not impact chinook salmon.

Steelhead trout would be primarily impacted by increased rearing temperatures in their riverine habitat. Alternative 1 - Option B and Alternative 4C/D would probably be the only alternatives that significantly impact the population.

No riverine striped bass impacts would be expected, but within the Delta and Bay the impacts would be significant. The primary environmental changes would be increased entrainment within the Delta, reduced food availability, and possible increased exposure to toxins. Only Alternatives 5 and 7, and possibly Alternative 2, would not cause significant impacts (Table 5-3).

The only riverine American shad impacts would occur under Alternative 1 - Option B. The impacts would be significant to the American River run, but probably would not be significant to the entire Sacramento River population. Impacts within the Delta would be the most significant for the population and would be caused primarily by entrainment and entrapment within the Delta and reduced food availability (Table 5-3).

Three special-status fish species have been identified. Winter-run chinook salmon would be most impacted by changes in riverine conditions, primarily deleterious temperatures during the spawning and rearing period. Alternative 1 - Option B and Alternative 4C/D would have the most significant impacts on the population. Significant impacts would also be expected under Alternatives 5, 6, and 7. Alternative 1 - Option A and Alternatives 2, 3, and 4 A/B would probably not significantly impact the population.

Delta smelt and Sacramento splittail are the other special-status species. Both would be impacted similarly and environmental changes within the Delta and Bay would cause the greatest impacts. Impacts would result primarily from reduced food availability and reduced habitat resulting from changes in salinity. Only Alternatives 5 and 7 would not be expected to cause significant population impacts (Table 5-3).

Folsom Reservoir fish populations would be significantly impacted under all alternatives. The primary environmental changes would be reduced productivity caused by reduced surface area and spawning failure caused by increased surface level fluctuations. Shasta and Clair Engle Reservoir fish populations would be significantly impacted only under Alternative 4C/D.

The broad category, "other species," contains nearly 100 species (Appendix IX, Table Q). Little is known about environmental conditions affecting these populations, but changes in the riverine habitat would probably not cause significant impacts. Delta and Bay environmental changes, however, would cause significant impacts to many species. The primary impact within the Delta would probably be reduced food availability. Bay species would probably be most impacted by reduced habitat area (increased salinity in San Pablo and Suisun Bays), reduced food availability, and possibly increased exposure to toxins.

Some Bay species would undoubtedly benefit, primarily marine species and species with unspecialized prey needs.

Mitigation Measures

Mitigation for riverine and reservoir fish population impacts is presented in the environmental consequences sections (Chapter 4, "Fisheries") of the SRSA, ARSA, and DESA EIS's. The mitigation described in this section is primarily for impacts within the Delta that would result from water contracting in all three service areas. Mitigation measures for impacts within San Francisco Bay are not identified because impacts on Bay fisheries cannot be clearly identified with existing information. Most of the mitigation measures described below would require further study prior to implementation to determine costs, effectiveness, and environmental impacts.

Mitigate Chinook Salmon Impacts Caused by Reduced Sacramento River Discharges. Chinook salmon would be impacted by reduced Sacramento River discharge to the Delta, primarily in May and June. Manipulation of upstream rearing area discharge and temperature (i.e., decreasing discharge, increasing temperature) might shorten or advance the migration period. During years when water temperature in the lower Sacramento River approaches deleterious levels early in the migration period, discharge could be increased during peak emigration, reducing impacts to less-than-significant levels. Further study is needed to determine the intricacies of chinook salmon emigration and the causes of recent elevated Sacramento River temperatures.

Mitigate Chinook Salmon Impacts Caused by Entrainment Within Delta. Chinook salmon juveniles would also be impacted by entrainment within the Delta. Cross-Delta flow from the Sacramento River causes the most significant impacts (Appendix IX, Tables G and H), but diversion of the San Joaquin River near Mossdale is most significant for San Joaquin River fish. Although San Joaquin River salmon were less-than-significantly impacted or not impacted under all alternatives, permanent blockage of Old River near Mossdale would significantly improve conditions for emigrant juvenile salmon.

Cross-Delta flow impacts to chinook salmon could be reduced to less-than-significant levels through closure of the Delta Cross Channel during peak migration (Sacramento River fish only), addition of offstream storage south of the Delta to enable temporal export flexibility (all chinook migrants), efficient screening of the Delta Cross Channel (Sacramento River migrants only), and transport of effectively screened Sacramento River water around the Delta rather than through it (all chinook migrants).

Mitigate Impacts to Other Species Caused by Cross-Delta Flow Increases. Cross-Delta flow increases cause the most significant impacts to striped bass, American shad, and all other Delta species, including Delta smelt, Sacramento splittail, catfish, and sunfish. Impacts to striped bass and American shad could be reduced, but not to less-than-significant levels, through closure of the Delta Cross Channel during peak passive and active migration, preventing Sacramento River fish from entering the central Delta. Combining the Delta Cross Channel closure with pulses of San Joaquin water through the central Delta during peak striped bass spawning would further reduce impacts, possibly to less-than-significant levels.

Add Offstream Storage South of Delta. Addition of offstream storage south of the Delta to enable temporal export flexibility could reduce all species impacts to less-than-significant levels, provided storage and water conveyance mechanisms were sufficient to permit adequate export during noncritical periods (primarily during winter months).

Reduce Delta Exports During Spring and Summer. Reduction of export during spring and summer would decrease entrainment in water moving toward the pumps, reduce the presence of Sacramento River water (which is relatively impoverished in zooplankton) in the central Delta, and increase residence times and food production within Delta waterways.

Vegetation and Wildlife

Affected Environment

Service Areas. Habitat types occurring within the SRSA, ARSA, and DESA are described in Chapter 3 of the SRWC EIS, ARWC EIS, and DEWC EIS, respectively.

Bay and Delta. The Delta and Bay complex includes various saltwater-tolerant wetland communities such as estuarine and saltwater marshes. Freshwater marshes and occasional narrow stringers of riparian vegetation line the edges of Delta waterways and vegetate undeveloped islands.

Saltwater marshes occur around the margins of the San Francisco and San Pablo Bays at and immediately above the tidal zone. Fourteen plant species typically occur in San Francisco Bay saltwater marshes (Atwater et al. 1979). Monocultures of common pickleweed typically dominate the upper margins of tidal flats, with California cordgrass fringing tidal plains. Less common species along slough edges and natural uplands include saltgrass, marsh grindelia, fat hen, alkali heath, and fleshy jaumea. Tidal marshes are dissected by sloughs and have expanses of unvegetated tidal mud flats.

Saltwater marshes provide important wintering habitat for a variety of diving duck species including canvasback, redhead, greater scaup, lesser scaup, ruddy duck, common goldeneye, bufflehead, and red-breasted merganser. Within the SRSA, the San Francisco Bay is a key wintering area for these species. This group of ducks feeds on both plant and animal life by diving in waters generally ranging from >6 feet to <25 feet in depth. Some of these species also breed in saltwater marsh areas and build their nests on emergent vegetation. A few diving species such as goldeneyes, buffleheads, and mergansers typically nest in tree cavities.

Geese and dabbling ducks (e.g., mallard, gadwall, northern shoveler, northern pintail, and American pigeon) also rest and occasionally forage in saltwater marsh habitats. Song sparrows, common yellowthroats, marsh wrens, red-winged blackbirds, and muskrats also breed and forage in these habitats. Several rare species including the salt marsh harvest mouse, Suisun shrew, clapper rail, and black rail occur in salt marshes of the San Francisco Bay.

Estuarine marshes develop where rivers bring fresh water into contact with saltwater. The reduced salinity, tidal fluctuations, alkaline soils, and freshwater inflows provide unique habitats for plants and wildlife as compared with saltwater marshes. Salinity varies daily with tides and seasonally with freshwater inflows. Suisun Marsh and the western edge of the Delta have the only estuarine marshes in the ARSA.

The herbaceous estuarine marsh community has mosaics of open water, tidal mud flats, low-matted herbaceous vegetation, and taller emergent marsh vegetation. About 40 plant species are reported from Suisun Marsh (Atwater and Hedel 1976). Cattails and tules dominate the marshes while saltgrass, pickleweed, alkali heath, and alkali bulrush dominate infrequently flooded sites. Baltic rush, brass buttons, fat hen, and various sedge and bulrush species are important subdominants. Suisun Marsh is divided into natural, tidally influenced habitats and diked, managed wetlands; the latter are flooded for waterfowl during 3-5 winter months and do not support marsh vegetation.

Suisun Marsh is highly significant to waterfowl and many aquatic species that form the basis of the San Francisco Bay food web. Suisun Marsh also helps filter pollutants and nutrients from Delta and river waters. Several special-status plant and animal species are endemic to the marsh and nearby areas. Suisun Marsh and its dependent plant and wildlife species are highly sensitive to the location of the saltwater/freshwater interface.

Soil salinity is the major factor influencing the distribution of dominant Bay-Delta marsh plants from the highly saline San Francisco Bay through Suisun and San Pablo Bays, to the Delta. Soil moisture, period of tidal inundation, and the soil organic content are also important secondary factors (Atwater and Hedel 1976, Mall 1969, Josselyn 1983). Soil salinity is influenced by Delta outflow because the substantial winter-spring freshwater inflows flush salt from the soils (Josselyn 1983) and because lowered summer inflows cause the inward shift of saline water from the Bay into the Delta (Department of Water Resources 1984).

The relationship between soil salinity and distribution of plant species is suggested by empirical data. Year-to-year survival of alkali bulrush depended on freshwater inflows; its survival within a zone between Pacific cordgrass and pickleweed depended on reductions in soil salinity during spring by high Delta outflows (Josselyn 1983). Salinity changes on a short-term scale have also influenced plant distributions. Pacific cordgrass invaded areas formally supporting California bulrush in Southampton Marsh (in the Carquinez Strait) during the 1976-77 drought.

In addition to its influence on plant distribution, Delta outflow exerts a strong effect on the ecology of the entire Bay ecosystem by regulating salinity and water circulation patterns that indirectly control distribution of nutrients, toxic materials, and effluent.

Delta outflow determines the location of the saltwater/freshwater interface and the nutrient entrapment zone where plankton, other microorganisms, and larval fish that form the base of the aquatic foodweb are produced in large numbers. When this transition zone is located opposite Suisun Marsh, the productivity of these microorganisms is significantly enhanced because the marsh influences patterns of nutrient mixing, concentrations,and settling (Arthur and Ball 1979). Water circulation in the south Bay, which controls salinity and flushes pollutants out of the Bay, is also influenced by Delta outflow (Conomos 1979).

The overall health and productivity of plants and wildlife using the Bay-Delta ecosystem, and the distribution of these organisms is thus directly influenced by Delta outflows. At least 230 species of birds and 43 species of mammals occur in the Delta (California Department of Fish and Game 1987a). During the 1970s, wintering waterfowl populations in the Delta averaged 450,000-600,000 birds (California Department of Fish and Game 1987a). Numbers of ducks have declined substantially throughout the flyway since then, while goose populations have remained relatively stable. Thousands of shorebirds use flooded fields in the Delta during late summer and fall.

The Suisun Marsh includes more than 10 percent of the remaining wetlands in California. As much as 25 percent of California's wintering waterfowl inhabit the marsh during dry winters (California Department of Fish and Game 1987a). Waterfowl are attracted to the marsh by the water and the abundance of natural food plants, the most valuable of which are alkali bulrush, fat hen, and brass buttons. Growth of such plants depends on proper soil salinity, which is determined by the salinity of applied water.

Freshwater and brackish areas in the eastern portion of the Bay, including Suisun Marsh, provide important habitats for puddle ducks and geese. Increases in salinity from past water diversions have altered habitats in the eastern portion of the Bay. Changes in vegetation and aquatic communities generally have been detrimental to puddle ducks (California Department of Fish and Game 1987a). A large water control gate was recently installed in Montezuma Slough to control saltwater intrusion and maintain waterfowl habitats in the Suisun Marsh.

San Francisco Bay (including Suisun, Grizzly, Honker, and San Pablo Bays) supports about 200 species of birds and 40 species of mammals (California Department of Fish and Game 1987b). The saltwater portions of the Bay support a large proportion of the diving ducks wintering in California.

The Suisun Marsh alone represents approximately 12 percent of all remaining marshland in California. It is a vital wintering area for ducks in the Pacific Flyway. A single aerial survey conducted in October 1974 at the marsh recorded 1,128,035 waterfowl or 28 percent of the waterfowl in the state at that time.

In addition to waterfowl, the marsh provides wintering habitat for more than 150 other species of wildlife including pied-billed grebe, eared grebe, double-crested cormorant, American white pelican, great blue heron, great egret, snowy egret, black-crowned night-heron, several species of gulls, American avocet, black-necked stilt, common snipe, western sandpiper, least sandpiper, sandhill crane, Virginia rail, and sora (California Department of Fish and Game 1981). The species in this group forage in a variety of wetland habitats ranging from deep water (grebe) to shallow water (heron and egret) and mud flats (shorebird). Nest sites are diverse and include trees (great blue heron), open ground (killdeer), and dense marsh vegetation (American bittern). Numerous birds of prey also frequent brackish and saltwater habitats of the Suisun Marsh and Delta, including northern harrier, black-shouldered kite, red-tailed hawk, rough-legged hawk, ferruginous hawk, Cooper's hawk, American kestrel, prairie falcon, and golden eagle.

Freshwater marshes were previously described in Chapter 3, but those in the Delta vary from Central Valley types. Some Delta marshes on silt and peat deposits of undisturbed, undiked peat islands are unique because they have a patchy shrub overstory and have been termed tule islands by the DFG and the USFWS (1980). The multilayered tule island habitat has a canopy of willow, alder, buttonwillow, and American dogwood; a freshwater marsh midstory; and herb layers with nettles, lady fern, spike rush, marsh pennywort, tules, bulrushes, chain fern, verbena, common reed grass, burr reed, and other species.

Impacts

Impacts in All Three Service Areas. The potential cumulative impacts of all project alternatives to biological communities and special-status species in the three service areas are summarized in Appendix X, Tables B, C, D, and E. Although the approximate numbers of linear feet of riparian habitat and acreages of freshwater/alkali marsh, open water, and terrestrial habitats have been calculated for the SRSA, such estimates do not exist for the ARSA or the DESA. Calculations were not made for the ARSA or DESA because the specific locations of CVP-induced impacts have generally not been identified. However, potential impacts to biological communities and special-status species were identified based on their known occurrences within the ARSA. Mitigation measures for significant impacts are presented in Chapter 4, "Vegetation and Wildlife" in each EIS.

Impacts on Bay and Delta

Delta Outflow Impacts. CVP water contracting would reduce Delta outflows under all alternatives (except the No-Action Alternative). The magnitude of reduction in Delta outflows, compared to the No-Action Alternative outflows, varies among the alternatives. Substantial reductions are associated with Alternatives 1B and 4. Smaller reductions in Delta outflows would occur under Alternatives 1A, 2, 3, and 6, while Alternatives 5 and 7 would probably have the least effect.

Vegetation of saltwater marshes in the San Francisco and San Pablo Bay would probably not be affected by changes in Delta outflows. In contrast, vegetation of the estuarine Suisun Marsh could be affected because it supports many brackish species that are intolerant of highly saline water. Insufficient information exists on Suisun Marsh salinity conditions under the water contracting alternatives. Under a worst-case scenario, significant impacts on marsh vegetation, wildlife, and special-status species could occur under those alternatives which reduce Delta outflow.

Mitigation Measures. Ongoing multiagency monitoring of Suisun Marsh water quality, vegetation, and wildlife would determine whether changes in Delta outflows would cause the potential adverse effects described above. If adverse effects are detected, changes in Suisun Marsh management, including operations of the recently installed water control gate, could be undertaken.

Recreation

Recreation impacts of Reclamation's water contracting alternatives within each of the three service areas summarized in Appendix VII. Possible mitigation measures for significant impacts are described in Chapter 4, "Recreation" in each EIS.

Aesthetics

Aesthetic (visual quality) impacts of Reclamation's water contracting alternatives within each of the three service areas are summarized in Appendix VII. Possible mitigation measures for significant impacts are described in Chapter 4, "Aesthetics" in each EIS.

Economics

This section describes economics effects resulting from the water deliveries throughout the CVP service area. Two types of economic effects are evaluated in this section. First, impacts on earnings and employment, as described in the "Economics" section of Chapter 4, are estimated for the CVP-wide service area. Total regional impacts, including direct, indirect, and induced effects within the CVP-wide service area are estimated using the Regional Interindustry Modeling System (RIMS) of the Bureau of Economic Analysis, U. S. Department of Commerce.

A second type of economic effect considered in this section is changes in the benefits (or net economic values) of water in different uses (e.g., irrigation, M&I, recreation, and power production).

Irrigation benefits were estimated as the cost savings from replacing groundwater pumping with contracting water. M&I benefits were estimated on the basis of the lowest cost, single purpose alternative for providing equivalent service. Recreation benefits were estimated using a regional travel cost model. Power benefits were calculated as the cost of replacing energy not generated under each of the water contracting alternatives. The negative benefit resulting from this calculation is based on the reduced generation only, with the reduced energy demand for groundwater pumping taken into account as part of the irrigation and M&I benefits.

It should be noted that the benefits described in this section are not a measure of the net benefits to society from water contracting because project costs for each alternative have not been considered. The calculation of the economic effects presented in this section is described in detail in Technical Appendix E - Economics and Recreation.

No-Action Alternative

Under the No-Action Alternative, irrigated acreage was assumed to remain virtually unchanged from existing conditions. It is anticipated that overdrafting of groundwater in the DESA and ARSA would continue, which would have an adverse effect on net income to irrigators. This effect would be less significant in the ARSA than in the DESA. M&I use would continue to increase, but significant impacts would occur only if water were growth limiting or another source of supply was not readily available. There would be less power generation than under existing conditions. Recreation activities would increase compared to existing conditions.

Alternative 1 - Option A

Under Alternative 1 - Option A, gross farm income would increase only about one percent over the No-Action Alternative (Table 5-4), so the impacts on earnings and employment from irrigation deliveries would be of minor significance. Irrigation deliveries would cause earnings to increase by $23 million (Table 5-5) and would create approximately 1,400 full-time equivalent jobs (Table 5-6). These earnings and jobs would be associated with the new acreage being irrigated in the SRSA. Recreation expenditures would decrease by about $2 million (Table 5-4), decreasing earnings and employment by approximately $1 million (Table 5-5) and nearly 80 jobs (Table 5-6), respectively.

Irrigation benefits or savings in water cost (Table 5-7) would be nearly $37 million, with most of these benefits being generated in the DESA. M&I benefits (Table 5-8) would be nearly $37 million, with the majority of the benefits from deliveries to the City of Folsom, San Juan Suburban Water District, Laguna/Elk Grove, and Sunrise East. Increased deliveries to irrigation and M&I needs would cause a loss of recreation and power benefits (Tables 5-9 and 5-10). Recreation benefits would decrease by nearly $10 million primarily because of reductions in recreational use at Folsom and Shasta reservoirs (Table 5-9). For power, PDC would decrease 71 MW with 210 GWh less generation annually. This decrease in power production would need to be replaced with purchases of $17 million of energy. Overall, the benefits from irrigation and M&I deliveries would outweigh losses to recreation and power generation, so the total project benefits for Alternative 1 - Option A would be about $44 million (Table 5-11).

Alternative 1 - Option B

Impacts on earnings and employment for Alternative 1 - Option B would be similar to those for Option A. As with Option A, irrigation deliveries would cause earnings to increase by $23 million (Table 5-5) and would create approximately 1,400 jobs (Table 5-6). These earnings and jobs would be associated with the new acreage being irrigated in the SRSA. Recreation expenditures would decrease by $5 million, causing earnings to drop nearly $3 million and the loss of 180 jobs.

Irrigation benefits (Table 5-7) would be over $31 million, with most of these benefits being generated in the DESA. M&I benefits (Table 5-8) would be over $44 million, with the majority of the benefits from deliveries to the City of Folsom, San Juan Suburban

TABLE 5-4. CHANGES IN FINAL DEMAND: CVP SYSTEM-WIDE AREA

INDUSTRY CLASSIFICATION	DESCRIPTION	BASE LEVEL FINAL DEMAND NO ACTION ALTERNATIVE ($1,000)	CHANGE IN FINAL DEMAND BY ALTERNATIVE /1 1 OPTION A ($1,000)	1 OPTION B ($1,000)	2 ($1,000)	3 ($1,000)	4A ($1,000)	4B ($1,000)	4C ($1,000)	4D ($1,000)	5 ($1,000)	6 ($1,000)	7 ($1,000)
AG:													
2.0100	COTTON	$624,997	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.0201	FOOD GRAINS	$160,154	$5,843	$5,843	$5,843	$5,843	$5,843	$5,843	$0	$0	$0	$5,843	$0
2.0202	FEED GRAINS	$313,634	$669	$669	$669	$669	$669	$669	$0	$0	$0	$669	$0
2.0203	GRASS SEEDS	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.0401	FRUITS	$1,185,698	$8,025	$8,025	$8,025	$8,025	$8,025	$8,025	$0	$0	$0	$8,025	$0
2.0402	TREE NUTS	$452,841	$2,804	$2,804	$2,804	$2,804	$2,804	$2,804	$0	$0	$0	$2,804	$0
2.0501	VEGETABLES	$354,910	$6,057	$6,057	$6,057	$6,057	$6,057	$6,057	$0	$0	$0	$6,057	$0
2.0502	SUGAR CROPS	$40,497	$5,283	$5,283	$5,283	$5,283	$5,283	$5,283	$0	$0	$0	$5,283	$0
2.0503	MISCELLANEOUS CROPS	$343,864	$7,791	$7,791	$7,791	$7,791	$7,791	$7,791	$0	$0	$0	$7,791	$0
2.0600	OIL BEARING CROPS	$7,686	($397)	($397)	($397)	($397)	($397)	($397)	$0	$0	$0	($397)	$0
	SUBTOTAL	$3,484,281 /2	$36,075	$36,075	$36,075	$36,075	$36,075	$36,075	$0	$0	$0	$36,075	$0
RECREATION:													
69.02	RETAIL TRADE		($1,164)	($2,835)	($1,261)	($1,068)	($1,710)	($1,710)	($4,184)	($4,184)	($3,507)	($2,434)	$1,318
74.00	EATING AND DRINKING		($136)	($177)	($315)	$43	$139	$139	($636)	($636)	($434)	($272)	$669
72.01	HOTELS AND LODGING		($386)	($972)	($412)	($360)	($689)	($689)	($1,167)	($1,167)	($948)	($790)	$532
79.03	GOVERNMENT ENTERPRISES		($380)	($1,019)	($363)	($398)	($591)	($591)	($1,395)	($1,395)	($1,217)	($828)	$175
	SUBTOTAL		($2,066)	($5,003)	($2,351)	($1,783)	($2,851)	($2,851)	($7,382)	($7,382)	($6,106)	($4,324)	$2,694
	TOTAL IMPACT		$34,009	$31,072	$33,724	$34,292	$33,224	$33,224	($7,382)	($7,382)	($6,106)	$31,751	$2,694

1/ CHANGE IN FINAL DEMAND IS DEFINED AS THE CHANGE IN GROSS INCOME FOR THE AGRICULTURAL SECTOR AND CHANGE IN EXPENDITURES FOR THE RECREATION SECTOR.

2/ GROSS INCOME FOR REQUESTOR AGENCIES ONLY

C-055872

TABLE 5-5. EARNINGS IMPACTS: CVP SYSTEM-WIDE AREA

INDUSTRY CLASSIFICATION	DESCRIPTION	EARNINGS MULTIPLIER	CHANGE IN EARNINGS BY ALTERNATIVE										
			1 OPTION A ($1,000)	1 OPTION B ($1,000)	2 ($1,000)	3 ($1,000)	4A ($1,000)	4B ($1,000)	4C ($1,000)	4D ($1,000)	5 ($1,000)	6 ($1,000)	7 ($1,000)
AG:													
2.0100	COTTON	0.5766	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.0201	FOOD GRAINS	0.5189	$3,032	$3,032	$3,032	$3,032	$3,032	$3,032	$0	$0	$0	$3,032	$0
2.0202	FEED GRAINS	0.4893	$327	$327	$327	$327	$327	$327	$0	$0	$0	$327	$0
2.0203	GRASS SEEDS	0.5715	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.0401	FRUITS	0.7110	$5,706	$5,706	$5,706	$5,706	$5,706	$5,706	$0	$0	$0	$5,706	$0
2.0402	TREE NUTS	0.7539	$2,114	$2,114	$2,114	$2,114	$2,114	$2,114	$0	$0	$0	$2,114	$0
2.0501	VEGETABLES	0.7214	$4,370	$4,370	$4,370	$4,370	$4,370	$4,370	$0	$0	$0	$4,370	$0
2.0502	SUGAR CROPS	0.6423	$3,393	$3,393	$3,393	$3,393	$3,393	$3,393	$0	$0	$0	$3,393	$0
2.0503	MISCELLANEOUS CROPS	0.5559	$4,331	$4,331	$4,331	$4,331	$4,331	$4,331	$0	$0	$0	$4,331	$0
2.0600	OIL BEARING CROPS	0.6180	($245)	($245)	($245)	($245)	($245)	($245)	$0	$0	$0	($245)	$0
	SUBTOTAL		$23,027	$23,027	$23,027	$23,027	$23,027	$23,027	$0	$0	$0	$23,027	$0
RECREATION:													
69.02	RETAIL TRADE	0.7462	($869)	($2,115)	($941)	($797)	($1,276)	($1,276)	($3,122)	($3,122)	($2,617)	($1,816)	$983
74.00	EATING AND DRINKING	0.5711	($78)	($101)	($180)	$25	$79	$79	($363)	($363)	($248)	($155)	$382
72.01	HOTELS AND LODGING	0.6146	($237)	($597)	($253)	($221)	($423)	($423)	($717)	($717)	($583)	($486)	$327
79.03	GOVERNMENT ENTERPRISES	0.0000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	SUBTOTAL		($1,184)	($2,814)	($1,374)	($994)	($1,620)	($1,620)	($4,203)	($4,203)	($3,447)	($2,457)	$1,693
	TOTAL IMPACT		$21,843	$20,213	$21,653	$22,034	$21,407	$21,407	($4,203)	($4,203)	($3,447)	$20,570	$1,693

MULTIPLIER DATA SOURCE: RIMS II, REGIONAL ECONOMIC ANALYSIS DIVISION, BUREAU OF ECONOMIC ANALYSIS, DEPARTMENT OF COMMERCE.

TABLE 5-6. EMPLOYMENT IMPACTS: CVP SYSTEM-WIDE AREA

INDUSTRY CLASSIFICATION	DESCRIPTION	EMPLOYMENT MULTIPLIER	CHANGE IN EMPLOYMENT BY ALTERNATIVE /1 1 OPTION A (JOBS)	1 OPTION B (JOBS)	2 (JOBS)	3 (JOBS)	4A (JOBS)	4B (JOBS)	4C (JOBS)	4D (JOBS)	5 (JOBS)	6 (JOBS)	7 (JOBS)
AG:													
2.0100	COTTON	35.5	0	0	0	0	0	0	0	0	0	0	0
2.0201	FOOD GRAINS	31.7	185	185	185	185	185	185	0	0	0	185	0
2.0202	FEED GRAINS	29.4	20	20	20	20	20	20	0	0	0	20	0
2.0203	GRASS SEEDS	35.1	0	0	0	0	0	0	0	0	0	0	0
2.0401	FRUITS	43.5	349	349	349	349	349	349	0	0	0	349	0
2.0402	TREE NUTS	46.7	131	131	131	131	131	131	0	0	0	131	0
2.0501	VEGETABLES	44.8	271	271	271	271	271	271	0	0	0	271	0
2.0502	SUGAR CROPS	39.8	210	210	210	210	210	210	0	0	0	210	0
2.0503	MISCELLANEOUS CROPS	33.6	262	262	262	262	262	262	0	0	0	262	0
2.0600	OIL BEARING CROPS	38.6	(15)	(15)	(15)	(15)	(15)	(15)	0	0	0	(15)	0
	SUBTOTAL		1,413	1,413	1,413	1,413	1,413	1,413	0	0	0	1,413	0
RECREATION:													
69.02	RETAIL TRADE	47.6	($55)	(135)	(60)	(51)	(81)	(81)	(199)	(199)	(167)	(116)	63
74.00	EATING AND DRINKING	58.9	($8)	(10)	(19)	3	8	8	(37)	(37)	(26)	(16)	39
72.01	HOTELS AND LODGING	38.9	($15)	(38)	(16)	(14)	(27)	(27)	(45)	(45)	(37)	(31)	21
79.03	GOVERNMENT ENTERPRISES	0.0	$0	0	0	0	0	0	0	0	0	0	0
	SUBTOTAL		(78)	(183)	(95)	(62)	(100)	(100)	(282)	(282)	(229)	(163)	123
	TOTAL IMPACT		1,335	1,230	1,318	1,351	1,313	1,313	(282)	(282)	(229)	1,250	123

1/ CHANGE IN NUMBER OF JOBS FOR EACH ADDITIONAL ONE MILLION DOLLARS' CHANGE IN FINAL DEMAND

MULTIPLIER DATA SOURCE: RIMS II, REGIONAL ECONOMIC ANALYSIS DIVISION, BUREAU OF ECONOMIC ANALYSIS, DEPARTMENT OF COMMERCE.

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TABLE 5-7. SAVINGS IN WATER COSTS RESULTING FROM CVP ALLOCATIONS:
CVP-WIDE SERVICE AREA

AGENCY	ALTERNATIVE 1 - OPTION A			ALTERNATIVE 1 - OPTION B			ALTERNATIVE 2		
	CVP ALLOCATION	WATER COST SAVINGS	SAVINGS PER PER AF /1	CVP ALLOCATION	WATER COST SAVINGS	SAVINGS PER PER AF /1	CVP ALLOCATION	WATER COST SAVINGS	SAVINGS PER PER AF /1
	AF	$	$/AF	AF	$	$/AF	AF	$	$/AF
SACRAMENTO RIVER SERVICE AREA									
TEHAMA-COLUSA CANAL	225,600	$2,724,564	$12.08	225,600	$2,724,564	$12.08	181,100	$2,183,536	$12.06
YOLO-SOLANO	42,000	$589,302	$14.03	42,000	$589,302	$14.03	0	$0	$0.00
SACRAMENTO RIVER TOTAL	267,600	3,313,866	$12.38	267,600	3,313,866	$12.38	181,100	$2,183,536	$12.06
AMERICAN RIVER SERVICE AREA									
SACRAMENTO COUNTY	120,900	$3,519,788	$29.11	120,900	$3,519,788	$29.11	112,400	$3,272,744	$29.12
SAN JOAQUIN COUNTY	172,000	$5,335,171	$31.02	172,000	$5,335,171	$31.02	0	$0	$0.00
AMERICAN RIVER TOTAL	292,900	$8,854,959	$30.23	292,900	$8,854,959	$30.23	112,400	$3,272,744	$29.12
DELTA EXPORT SERVICE AREA									
SAN JOAQUIN RIVER BASIN	281,850	$17,439,876	$61.88	332,480	$17,956,978	$54.01	250,000	$16,031,250	$64.13
TULARE LAKE BASIN	154,850	$5,000,140	$32.29	37,620	$1,214,846	$32.29	0	$0	$0.00
DELTA EXPORT TOTAL	436,700	$22,440,016	$51.39	370,100	$19,171,824	$51.80	250,000	$16,031,250	$64.13
CVP SERVICE AREA TOTAL	997,200	$34,608,841	$34.71	930,600	$31,340,649	$33.68	543,500	$21,487,530	$39.54

1/ SAVINGS PER ACRE FOOT IS THE PRODUCT OF THE DISTRICTS' GROUNDWATER COST AND DELIVERY EFFICIENCY

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AGENCY	ALTERNATIVE 3 CVP ALLOCATION	ALTERNATIVE 3 WATER COST SAVINGS	ALTERNATIVE 3 SAVINGS PER PER AF /1	ALTERNATIVE 4A CVP ALLOCATION	ALTERNATIVE 4A WATER COST SAVINGS	ALTERNATIVE 4A SAVINGS PER PER AF /1	ALTERNATIVE 4B CVP ALLOCATION	ALTERNATIVE 4B WATER COST SAVINGS	ALTERNATIVE 4B SAVINGS PER PER AF /1
	AF	$	$/AF	AF	$	$/AF	AF	$	$/AF
SACRAMENTO RIVER SERVICE AREA									
TEHAMA-COLUSA CANAL	225,600	$2,724,564	$12.08	181,100	$2,183,536	$12.06	181,100	$2,183,536	$12.06
YOLO-SOLANO	42,000	$589,302	$14.03	0	$0	$0.00	0	$0	$0.00
SACRAMENTO RIVER TOTAL	267,600	$3,313,866	$12.38	181,100	$2,183,536	$12.06	181,100	$2,183,536	$12.06
AMERICAN RIVER SERVICE AREA									
SACRAMENTO COUNTY	120,900	$3,519,788	$29.11	112,400	$3,272,744	$29.12	112,400	$3,272,744	$29.12
SAN JOAQUIN COUNTY	172,000	$5,335,171	$31.02	0	$0	$0.00	0	$0	$0.00
AMERICAN RIVER TOTAL	292,900	$8,854,959	$30.23	112,400	$3,272,744	$29.12	112,400	$3,272,744	$29.12
DELTA EXPORT SERVICE AREA									
SAN JOAQUIN RIVER BASIN	308,000	$17,121,825	$55.59	555,300	$32,979,938	$59.39	506,210	$26,674,299	$52.69
TULARE LAKE BASIN	0	$0	$0.00	67,360	$2,408,496	$35.76	176,120	$6,931,538	$39.36
DELTA EXPORT TOTAL	308,000	$17,121,825	$55.59	622,660	$35,388,434	$56.83	682,330	$33,605,837	$49.25
CVP SERVICE AREA TOTAL	868,500	$29,290,650	$33.73	916,160	$40,844,714	$44.58	975,830	$39,062,117	$40.03

AGENCY	ALTERNATIVE 4C CVP ALLOCATION	ALTERNATIVE 4C WATER COST SAVINGS	ALTERNATIVE 4C SAVINGS PER PER AF /1	ALTERNATIVE 4D CVP ALLOCATION	ALTERNATIVE 4D WATER COST SAVINGS	ALTERNATIVE 4D SAVINGS PER PER AF /1	ALTERNATIVE 6 CVP ALLOCATION	ALTERNATIVE 6 WATER COST SAVINGS	ALTERNATIVE 6 SAVINGS PER PER AF /1
	AF	$	$/AF	AF	$	$/AF	AF	$	$/AF
SACRAMENTO RIVER SERVICE AREA									
TEHAMA-COLUSA CANAL	0	$0	$0.00	0	$0	$0.00	181,100	$2,183,536	$12.06
YOLO-SOLANO	0	$0	$0.00	0	$0	$0.00	0	$0	$0.00
SACRAMENTO RIVER TOTAL	0	$0	$0.00	0	$0	$0.00	181,100	$2,183,536	$12.06
AMERICAN RIVER SERVICE AREA									
SACRAMENTO COUNTY	0	$0	$0.00	0	$0	$0.00	112,400	$3,272,744	$29.12
SAN JOAQUIN COUNTY	0	$0	$0.00	0	$0	$0.00	0	$0	$0.00
AMERICAN RIVER TOTAL	0	$0	$0.00	0	$0	$0.00	112,400	$3,272,744	$29.12
DELTA EXPORT SERVICE AREA									
SAN JOAQUIN RIVER BASIN	523,210	$33,055,313	$63.18	1,134,370	$54,024,553	$47.63	402,930	$21,162,856	$52.52
TULARE LAKE BASIN	614,650	$23,216,839	$37.77	0	$0	$0.00	94,970	$3,634,326	$38.27
DELTA EXPORT TOTAL	1,137,860	$56,272,152	$49.45	1,134,370	$54,024,553	$47.63	497,900	$24,797,182	$49.80
CVP SERVICE AREA TOTAL	1,137,860	$56,272,152	$49.45	1,134,370	$54,024,553	$47.63	791,400	$30,253,462	$38.23

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TABLE 5-8. DIRECT BENEFITS FOR MUNICIPAL AND INDUSTRIAL WATER

	TYPICAL GROUNDWATER COSTS (NO ACTION) ($/af)	SURFACE WATER COSTS ($/af)	M&I BENEFIT ($/af)	ALTERNATIVE 1 OPTION A		ALTERNATIVE 1 OPTION B		ALTERNATIVE 2		ALTERNATIVE 3		ALTERNATIVE 4A	
				CVP WATER (af) (a)	TOTAL BENEFITS ($/af)	CVP WATER (af) (a)	TOTAL BENEFITS ($/af)	CVP WATER (af)	TOTAL BENEFITS ($/af)	CVP WATER (af)	TOTAL BENEFITS ($/af)	CVP WATER (af)	TOTAL BENEFITS ($/af)
SACRAMENTO RIVER SERVICE AREA													
SHASTA DAM PUD	NA	226	226	4,800	1,084,800	4,800	1,084,800	4,800	1,084,800	4,800	1,084,800	4,800	1,084,800
YOLO-SOLANO CVP WATER SERVICE COORDINATING GROUP	16		16	100,400	1,573,268	100,400	1,573,268	0	0	100,400	1,573,268	0	0
SUBTOTAL				105,200	2,658,068	105,200	2,658,068	4,800	1,084,800	105,200	2,658,068	4,800	1,084,800
AMERICAN RIVER SERVICE AREA													
CITY OF FOLSOM	NA	226	226	18,900	4,271,400	20,900	4,723,400	18,900	4,271,400	20,900	4,723,400	18,900	4,271,400
MULTIDISTRICT (EXCEPT SJ SUBURB)	34		34	44,100	1,506,456	44,100	1,506,456	37,600	1,284,416	44,100	1,506,456	40,100	1,369,816
SAN JUAN SUBURBAN DISTRICT	NA	226	226	23,600	5,333,600	26,100	5,898,600	23,600	5,333,600	26,100	5,898,600	23,600	5,333,600
SACRAMENTO COUNTY WATER AGENCY													
CITY OF GALT (b)	NA	226	226	9,000	2,034,000	9,900	2,237,400	9,000	2,034,000	9,900	2,237,400	9,000	2,034,000
LAGUNA/ELK GROVE (b)	NA	226	226	70,300	15,887,800	77,700	17,560,200	70,300	15,887,800	77,700	17,560,200	70,300	15,887,800
SUNRISE EAST	NA	226	226	15,600	3,525,600	17,200	3,887,200	15,600	3,525,600	17,200	3,887,200	15,600	3,525,600
MATHER AFB	36		36	350	12,695	350	12,695	350	12,695	350	12,695	350	12,695
STOCKTON EAST WATER DISTRICT	29		29	49,000	1,399,440	49,000	1,399,440	0	0	49,000	1,399,440	0	0
SUBTOTAL				230,850	33,970,991	245,250	37,225,391	175,350	32,349,511	245,250	37,225,391	177,850	32,434,911
DELTA EXPORT SERVICE AREA													
CITY OF DOS PALOS	NA	226	226	0	0	1,300	293,800	0	0	0	0	1,300	293,800
CAWELO WD	95		95	0	0	0	0	0	0	0	0	0	0
CITY OF MENDOTA	23		23	0	0	5,000	112,500	0	0	0	0	5,000	112,500
CITY OF TRACY	188	226	226	0	0	4,100	926,600	0	0	4,100	926,600	4,100	926,600
CITY OF CORCORAN	86		86	0	0	0	0	0	0	0	0	0	0
CITY OF HANFORD	20		20	0	0	0	0	0	0	0	0	0	0
FRESNO CO. CSA 34#	NA	226	226	0	0	0	0	0	0	0	0	1,390	314,140
MUSCO OLIVE PRODUCTS	NA	226	226	0	0	600	135,600	0	0	600	135,600	600	135,600
SANTA NELLA CO. WD	NA	226	226	0	0	10,700	2,418,200	0	0	5,750	1,299,500	10,700	2,418,200
TRACY GOLF & C.C.	NA	226	226	0	0	700	158,200	0	0	700	158,200	700	158,200
VETERANS ADMIN	NA	226	226	850	192,100	850	192,100	0	0	850	192,100	850	192,100
WESTLANDS WD	NA		0	0	0	0	0	0	0	0	0	2,700	0
SUBTOTAL				850	192,100	23,250	4,237,000	0	0	12,000	2,712,000	27,340	4,551,140
GRAND TOTAL				336,900	36,821,159	373,700	44,120,459	180,150	33,434,311	362,450	42,595,459	209,990	38,070,851

(a) For those districts without a groundwater alternative, CVP water deliveries are based on firm yield only.

(b) Groundwater quality problems would eliminate groundwater as a supply option for these districts.

	ALTERNATIVE 4B		ALTERNATIVE 4C		ALTERNATIVE 4D		ALTERNATIVE 5		ALTERNATIVE 6		ALTERNATIVE 7	
	CVP WATER (af)	TOTAL BENEFITS ($/af)	CVP WATER (af)	TOTAL BENEFITS ($/af)	CVP WATER (af)	TOTAL BENEFITS ($/af)	CVP WATER (af)	TOTAL BENEFITS ($/af)	CVP WATER (af)	TOTAL BENEFITS ($/af)	CVP WATER (af)	TOTAL BENEFITS ($/af)
SACRAMENTO RIVER SERVICE AREA												
SHASTA DAM PUD	4,800	1,084,800	4,800	1,084,800	4,800	1,084,800	0	0	4,800	1,084,800	0	0
YOLO-SOLANO CVP WATER SERVICE COORDINATING GROUP	0	0	0	0	0	0	0	0	0	0	0	0
SUBTOTAL	4,800	1,084,800	4,800	1,084,800	4,800	1,084,800	0	0	4,800	1,084,800	0	0
AMERICAN RIVER SERVICE AREA												
CITY OF FOLSOM	18,900	4,271,400	0	0	0	0	0	0	20,900	4,723,400	0	0
MULTIDISTRICT (EXCEPT SJ SUBURB)	40,100	1,369,816	0	0	0	0	0	0	44,100	1,506,456	0	0
SAN JUAN SUBURBAN DISTRICT	23,600	5,333,600	0	0	0	0	0	0	26,100	5,898,600	0	0
SACRAMENTO COUNTY WATER AGENCY												
CITY OF GALT (b)	9,000	2,034,000	0	0	0	0	0	0	9,900	2,237,400	0	0
LAGUNA/ELK GROVE (b)	70,300	15,887,800	0	0	0	0	0	0	77,700	17,560,200	0	0
SUNRISE EAST	15,600	3,525,600	0	0	0	0	0	0	17,200	3,887,200	0	0
MATHER AFB	350	12,695	0	0	0	0	0	0	350	12,695	0	0
STOCKTON EAST WATER DISTRICT	0	0	0	0	0	0	0	0	0	0	0	0
SUBTOTAL	177,850	32,434,911	0	0	0	0	0	0	196,250	35,825,951	0	0
DELTA EXPORT SERVICE AREA												
CITY OF DOS PALOS	0	0	0	0	1,300	293,800	0	0	1,300	293,800	0	0
CAWELO WD	3,640	345,800	10,000	950,000	0	0	0	0	1,660	157,700	0	0
CITY OF MENDOTA	0	0	0	0	5,000	112,500	0	0	0	0	0	0
CITY OF TRACY	0	0	0	0	4,100	926,600	0	0	4,100	926,600	0	0
CITY OF CORCORAN	620	53,010	1,700	145,350	0	0	0	0	280	23,940	0	0
CITY OF HANFORD	3,410	66,666	9,360	182,988	0	0	0	0	1,550	30,303	0	0
FRESNO CO. CSA 34#	0	0	0	0	1,390	314,140	0	0	0	0	0	0
MUSCO OLIVE PRODUCTS	0	0	0	0	600	135,600	0	0	600	135,600	0	0
SANTA NELLA CO. WD	0	0	0	0	10,700	2,418,200	0	0	10,700	2,418,200	0	0
TRACY GOLF & C.C.	0	0	0	0	700	158,200	0	0	700	158,200	0	0
VETERANS ADMIN	0	0	0	0	850	192,100	0	0	850	192,100	0	0
WESTLANDS WD	0	0	2,700	0	2,700	0	0	0	0	0	0	0
SUBTOTAL	7,670	465,476	23,760	1,278,338	27,340	4,551,140	0	0	21,740	4,336,443	0	0
GRAND TOTAL	190,320	33,985,186	28,560	2,363,138	32,140	5,635,940	0	0	222,790	41,247,193	0	0

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Table 5-9. Recreation Benefits by Alternative and Service Area

Service Area/Recreation Site	No Action	Changes Compared to No Action: Alternative 1 Option A	Alternative 1 Option B	Alternative 2	Alternative 3	Alternative 4A/B	Alternative 4C/D	Alternative 5	Alternative 6	Alternative 7
Sacramento River Service Area										
Shasta Reservoir	$289,675,000	($10,630,500)	($36,571,000)	($7,351,000)	($13,910,000)	($7,351,000)	($23,804,000)	($23,804,000)	($18,239,000)	($5,847,000)
Claire Engle Reservoir	$85,545,000	($251,500)	$15,287,000	($431,000)	($72,000)	($431,000)	($19,413,000)	($17,960,000)	$2,326,000	$1,493,000
Sacramento River	$71,185,000	($25,000)	($1,229,000)	($724,000)	$674,000	($724,000)	$566,000	($787,000)	$466,000	$33,000
Sacramento NWR	$0	$1,544,612	$1,553,183	$0	$1,554,612	$0	$1,554,612	$1,553,183	$1,554,612	$1,553,183
Colusa NWR	$0	$238,939	$238,939	$0	$238,939	$0	$238,939	$238,939	$238,939	$238,939
Delevan NWR	$0	$243,036	$259,421	$0	$243,036	$0	$243,036	$259,421	$243,036	$259,421
Sutter NWR	$0	$84,003	$95,403	$0	$84,003	$0	$84,003	$95,403	$84,003	$95,403
Gray Lodge NWR	$4,038,876	$2,420,231	$3,855,696	$0	$2,420,231	$0	$2,420,231	$3,855,696	$2,420,231	$3,855,696
Subtotal	$450,443,875	($6,376,179)	($16,510,359)	($8,506,000)	($8,777,179)	($8,506,000)	($38,120,179)	($30,983,359)	($18,374,179)	$13,375,641
American River Service Area										
Folsom Reservoir	$103,727,000	($4,555,500)	($21,455,000)	($3,968,000)	($5,143,000)	($3,968,000)	($8,245,000)	($10,573,000)	($10,740,000)	($8,243,000)
American River	$127,670,000	($1,055,000)	($1,115,000)	($1,031,000)	($1,079,000)	($1,031,000)	$298,000	$132,000	($216,000)	$398,000
Subtotal	$231,397,000	($5,610,500)	($22,570,000)	($4,999,000)	($6,222,000)	($4,999,000)	($7,947,000)	($10,441,000)	($10,956,000)	($7,845,000)
Delta Export Service Area										
Grasslands RCD	$2,507,050	$489,013	$1,234,240	$0	$489,013	$0	$489,013	$1,234,240	$489,013	$1,234,240
Kesterson NWR	$58,241	$0	$36,917	$0	$0	$0	$0	$36,917	$0	$36,917
Mendota WMA	$404,709	$0	$200,041	$0	$0	$0	$0	$200,041	$0	$200,041
Volta WMA	$191,968	$0	$164,308	$0	$0	$0	$0	$164,308	$0	$164,308
Los Banos WMA	$380,989	$565,464	$696,299	$0	$565,464	$0	$565,464	$696,299	$565,464	$696,299
Kern NWR	$8,541	$174,887	$417,934	$0	$174,887	$0	$174,887	$417,934	$174,887	$417,934
San Luis NWR	$0	$616,624	$968,190	$0	$616,624	$0	$616,624	$968,190	$616,624	$968,190
Merced NWR	$0	$77,953	$281,478	$0	$77,953	$0	$77,953	$281,478	$77,953	$281,478
Pixley NWR	$21,417	$174,088	$261,315	$0	$174,088	$0	$174,088	$261,315	$174,088	$261,315
Subtotal	$3,572,915	$2,098,029	$4,260,721	$0	$2,098,029	$0	$2,098,029	$4,260,721	$2,098,029	$4,260,721
TOTAL All Service Areas and Sites	$685,413,790	($9,888,650)	($34,819,638)	($13,505,000)	($12,901,150)	($13,505,000)	($43,969,150)	($37,163,638)	($27,232,150)	$9,791,362

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TABLE 5-10 POWER BENEFITS BY ALTERNATIVE
CVP SYSTEMWIDE

ALTERNATIVE	PROJECT DEPENDABLE CAPACITY	AVERAGE GENERATION AVAILABLE FOR SALE	POWER VALUE /1	POWER BENEFIT /2
	(MW)	(GWH)	(1000 $)	(1000 $)
NO ACTION	926	3,600	295,200	
ALTERNATIVE 1 - OPTION A /3	855	3,390	277,980	(17,220)
ALTERNATIVE 1 - OPTION B	779	3,180	260,760	(34,440)
ALTERNATIVE 2	848	3,390	277,980	(17,220)
ALTERNATIVE 3	890	3,550 /4	291,100	(4,100)
ALTERNATIVE 4A AND 4B	820	3,240 /5	265,680	(29,520)
ALTERNATIVE 4C AND 4D	759	2,810	230,420	(64,780)
ALTERNATIVE 5	870	3,500	287,000	(8,200)
ALTERNATIVE 6	815	3,290	269,780	(25,420)
ALTERNATIVE 7	924	3,580	293,560	(1,640)

1/ BASED ON THE COST OF REPLACING ENERGY LOSSES WITH PURCHASES FROM PG&E, ESTIMATED AT $82 PER GWH.

2/ CHANGE FROM THE NO-ACTION ALTERNATIVE

3/ AVERAGE OF ALTERNATIVES 3 AND 4A USED TO REFLECT IMPACT OF ALTERNATIVE 1 - OPTION A.

4/ MODEL OUTPUT ADJUSTED TO REFLECT ADDITION OF ALLOCATION TO DELTA EXPORT WHICH REQUIRES USE OF ENERGY FOR THE EXPORT PUMPS.

5/ MODEL OUTPUT ADJUSTED TO REFLECT ADDITION OF ALLOCATION OF WATER TO SRSA AND ARSA.

TABLE 5-11. SUMMARY OF ECONOMIC BENEFITS BY ALTERNATIVE /1
CVP SYSTEMWIDE

	($ 1000)				
ALTERNATIVE	IRRIGATION	M&I	RECREATION	POWER	TOTAL
1 - OPTION A	34,609	36,821	(9,888)	(17,220)	44,322
1 - OPTION B	31,341	44,120	(34,819)	(34,440)	6,202
2	21,488	33,434	(13,505)	(17,220)	24,197
3	29,291	42,595	(12,901)	(4,100)	54,885
4A	40,845	38,071	(13,505)	(29,520)	35,891
4B	39,062	33,985	(13,505)	(29,520)	30,022
4C	56,272	2,363	(43,969)	(64,780)	(50,114)
4D	54,024	5,636	(43,969)	(64,780)	(49,089)
5	0	0	(37,163)	(8,200)	(45,363)
6	30,253	41,247	(27,232)	(25,420)	18,848
7	0	0	9,791	(1,640)	8,151

1/ ESTIMATES REPRESENT THE CHANGE FROM THE NO-ACTION ALTERNATIVE

Water District, Laguna/Elk Grove, and Sunrise East. Increased deliveries to irrigation and M&I needs would adversely affect recreation and power generation (Tables 5-9 and 5-10). Recreation benefits would decrease by approximately $35 million. For power, PDC would decrease 147 MW with 420 GWh less generation annually. This decrease in power production would need to be replaced with purchases of $34 million of energy. Overall, benefits from irrigation and M&I deliveries for Alternative 1 - Option B would outweigh losses to recreation and power generation, resulting in a total project benefit of about $6 million.

Alternative 2

Impacts on earnings and employment for Alternative 2 would be the same as Alternative 1 - Option A with respect to irrigation. Irrigation deliveries would cause earnings to increase by $23 million (Table 5-5) and would create approximately 1,400 jobs (Table 5-6). These earnings and jobs would be associated with the new acreage being irrigated in the SRSA. Recreation expenditures would decrease by over $2 million, causing an earnings drop of over $1 million and the loss of nearly 100 jobs.

Irrigation benefits (Table 5-7) would be approximately $21 million, with most of these benefits being generated in the DESA. M&I, recreation, and power benefits (Tables 5-8, 5-9, and 5-10) would be similar to Alternative 1 - Option A. Overall, Alternative 2 benefits from irrigation and M&I deliveries would outweigh losses to recreation and power generation, with a total benefit of $24 million.

Alternative 3

The impacts on earnings and employment from changes in irrigation deliveries are the same for Alternative 3 as for Alternative 1 - Option A. Recreation expenditures would decrease by almost $2 million, causing earnings to drop nearly $1 million and the loss of about 60 jobs.

Irrigation benefits (Table 5-7) would be in excess of $29 million, with most of these benefits being generated in the DESA. M&I benefits (Table 5-8) would be approximately $43 million, with the majority of the benefits from deliveries to the City of Folsom, San Juan Suburban Water District, Laguna/Elk Grove, and Sunrise East. There would be negative recreation and power benefits of about $13 million and $4 million, respectively (Tables 5-9 and 5-10). The adverse affect on recreation is caused primarily by reductions in recreation use at Folsom and Shasta Reservoirs (Table 5-9). For power, PDC would decrease 36 MW with 50 GWh less generation annually. This decrease in power production would need to be replaced with purchases of about $4 million of energy. Overall, the benefits from irrigation and M&I deliveries would outweigh losses to recreation and power generation, resulting in a total project benefit of $55 million.

Alternative 4A

Under Alternative 4A, the impacts on earnings and employment from irrigation would be the same as Alternative 1 - Option A. Recreation expenditures would decrease by $3 million, causing earnings to drop approximately $2 million and the loss of 100 jobs.

Increased deliveries to the DESA would provide irrigation benefits under this alternative but would cause a loss in recreation and power benefits. Irrigation benefits (Table 5-7) would be approximately $41 million. M&I benefits (Table 5-8) would be approximately $38 million, with the majority of the benefits from deliveries to the City of Folsom, San Juan Suburban Water District, Laguna/Elk Grove, and Sunrise East. Recreation benefits would decrease approximately $14 million (Table 5-9). For power, PDC would decrease 106 MW with 360 GWh less generation annually (Table 5-10). This decrease in power production would need to be replaced with purchases of near $30 million of energy. Overall, Alternative 4A benefits from irrigation and M&I deliveries would outweigh losses to recreation and power generation, resulting in a total project benefit of $36 million.

Alternative 4B

Alternative 4B is very similar to Alternative 4A, with the impacts on earnings and employment the same but with irrigation and M&I benefits slightly lower. Overall, Alternative 4B benefits from irrigation and M&I deliveries would outweigh losses to recreation and power generation, resulting in a total project benefit of $30 million.

Alternative 4C

Under Alternative 4C, there would be no impacts on earnings and employment from irrigation. Gross farm income would be the same as the No-Action Alternative. Recreation expenditures would decrease by over $7 million, causing earnings to drop over $4 million and the loss of about 280 jobs.

This alternative maximizes irrigation deliveries to the DESA, creating irrigation benefits, but causing a large reduction in recreation and power benefits. Irrigation benefits (Table 5-7) would be approximately $56 million. M&I benefits (Table 5-8) would be approximately $2 million, as M&I deliveries would be minimal. Recreation benefits would decrease by $44 million (Table 5-9). For power, PDC would decrease 167 MW with 790 GWh less generation annually (Table 5-10). This decrease in power production would need to be replaced with purchases of nearly $65 million of energy. Overall, the negative benefits from recreation and power generation would exceed the irrigation and M&I benefits, resulting in a negative $50 million total project benefit.

Alternative 4D

Alternative 4D is very similar to Alternative 4C with the impacts on earnings and employment the same, but with irrigation benefits slightly lower and M&I benefits slightly higher. Overall, the total project benefits would be a negative $49 million.

Alternative 5

Alternative 5 emphasizes deliveries to fish and wildlife resources. There would be no irrigation and M&I deliveries, and therefore no associated impact. However, there would be a reduction in recreation expenditures of about $6 million from a decrease in visitation at Folsom and Shasta Reservoirs. This loss of spending would cause earnings to drop over $3 million and cause the loss of 230 jobs.

The loss of visitation at Shasta and Folsom Reservoirs would cause a negative recreation benefit of $37 million, based on a comparison with the No-Action Alternative. For power, PDC would decrease 56 MW with 100 GWh less generation annually. This decrease in power production would need to be replaced with purchases of about $8 million of energy from PG&E. Overall, the losses from recreation and power generation would total $45 million for Alternative 5.

Alternative 6

Alternative 6 would create impacts on earnings and employment similar to those of Alternative 1 - Option B. Irrigation and M&I benefits would also be similar to Option B, but recreation and power benefits would not be as adversely affected as in Option B. Overall, Alternative 6 total project benefits would be about $19 million.

Alternative 7

Alternative 7 would give priority to recreational needs at Shasta Reservoir, Folsom Reservoir, and the lower American River, causing almost $3 million in increased expenditures on recreation. These expenditures would create earnings of approximately $2 million and create about 120 jobs.

No irrigation or M&I benefits would occur under Alternative 7. Recreation benefits would be about $10 million. Power benefits would be negative, causing nearly $2 million to be spent to replace energy. Overall, this alternative would provide total project benefits of $8 million.

Land Use

Land use impacts of Reclamation's water contracting alternatives within each of the three service areas are summarized in Appendix VII. Possible mitigation measures for significant impacts are described in Chapter 4, "Land Use," in each EIS.

Population, Housing, and Related Social Impacts

As described in the "Population, Housing and Related Social Impacts" section of Chapter 4 in each EIS, Reclamation's water contracting alternatives would not cause significant regional impacts on population, housing, and related issues. Appendix VII summarizes impacts within each service area.

Cultural Resources

Reclamation's water contracting alternatives would have potentially significant effects on cultural resources at Shasta Reservoir and Folsom Reservoir due to increased reservoir fluctuations. These impacts are summarized in Appendix VII. Possible mitigation measures are described in Chapter 4, "Cultural Resources," in each EIS.

HISTORICAL PERSPECTIVES ON CENTRAL VALLEY, BAY, AND DELTA BIOLOGICAL RESOURCES

As described in the EIS Introduction (Chapter 1), development of the CVP has resulted in major economic and social benefits throughout California. Scoping process participants, however, have commented that past and present CVP operations may also have contributed to adverse impacts on Central Valley, Bay, and Delta fisheries, vegetation and wildlife resources. Appendices VIII and X present historical perspectives on fisheries and vegetation and wildlife, respectively. These appendices also identify opportunities for Reclamation to mitigate impacts directly attributable to the CVP.

Fisheries

Appendix VIII documents historical changes in Central Valley, Bay, and Delta fisheries. The potential role of CVP facilities in causing fisheries impacts and present and potential future mitigation measures are discussed for the following surface waters: Trinity River, Clear Creek, Sacramento River, American River, San Joaquin River, Stanislaus River, and Delta waterways. Conclusions reached in Appendix VIII are as follows:

- Trinity River: As a consequence of activities that include but are not limited to (1) blockage of gravel recruitment past, and altered riverflow and water temperature regimes downstream of, Lewiston Dam; (2) improper land use and forest harvest practices throughout the basin; (3) excessive fish harvest; and (4) other unrelated CVP activities, the fisheries of the Trinity have been impacted. Reclamation has mitigation goals for producing fish at the Lewiston Fish Hatchery which have been met in recent years, and hatchery modifications are currently underway which will allow these goals to be exceeded. In addition to Reclamation, the USFWS and the DFG are participating in the Trinity River Restoration Program which includes watershed rehabilitation. Reclamation is providing separate funds for a 12-year instream flow study of the Trinity River by the USFWS.

- Clear Creek: Improvements to the fishery in Clear Creek include instream habitat restoration, flow augmentation, and removal of (or major modification to) Saeltzer Dam. These improvements could be a part of the efforts to increase Central Valley anadromous fish populations.

- Sacramento River: A number of activities have contributed to the condition of the existing fisheries on the Sacramento River. Reclamation is conducting several projects to improve conditions for the anadromous fish in the Sacramento River, including the installation of a temperature curtain behind Shasta Dam to improve temperatures for anadromous fish, the Red Bluff Diversion Dam Fish Passage Program, the installation of fish spawning gravels, and the provision of project power for the Coleman Fish Hatchery to maintain sufficiently cold water for fish production.

- American River: The Nimbus Salmon and Steelhead Hatchery is operated to mitigate impacts of Folsom and Nimbus Dams on chinook salmon and steelhead populations. Reclamation is modernizing the hatchery to ensure that mitigation goals are met or exceeded and has purchased supplementary incubator trays, so eggs can be collected and hatched at the Feather River Hatchery during years that American River temperatures are too high. In addition, Reclamation is exploring operational and structural modifications to improve conditions in the lower American River for natural salmon spawning.

- San Joaquin River: Friant Dam and other development along the San Joaquin River have impacted anadromous fisheries on the upper reaches of the main stem of the San Joaquin River. These impacts have not been mitigated but could be reduced through hatchery production in conjunction with increased instream flows.

- Stanislaus River: Historic fisheries declines in the Stanislaus River are not attributable to New Melones Reservoir since Goodwin Dam was previously constructed downstream from New Melones Dam and prevented the migration of anadromous fish. Reclamation has agreed to provide releases from New Melones to maintain habitat for chinook salmon below Goodwin Dam and to conduct studies, some of which are underway, to identify long-term instream flow needs.

- o <u>Delta Waterways</u>: Delta fisheries have clearly been impacted by water development in the Delta and upstream diversions. The amount of these impacts clearly attributable to CVP is not known. Reclamation is presently (1) negotiating an agreement with DFG for direct Tracy Pumping Plant impacts, (2) participating in a number of studies to improve Delta fisheries conditions, and (3) participating in a program to improve environmental conditions in the Suisun Marsh.

Vegetation and Wildlife

Appendix X documents historical changes in Central Valley, Bay, and Delta vegetation and wildlife. Very few of these historical changes are directly attributable to development of the CVP, although the CVP played some role in causing some of the changes, for example, through providing water supplies supporting agricultural and urban development within contracting agencies. Reclamation will continue to work with the agencies to develop programs to protect vegetation and wildlife resources in the Central Valley, Bay, and Delta.

CUMULATIVE IMPACTS OF FUTURE RELATED ACTIONS

A large number of future projects or actions by Reclamation or other entities could cause environmental effects that add to those of Reclamation's proposed water contracting actions. Many of these projects or actions, and their general relationship to Reclamation's water contracting program, are reviewed in the "Related Actions" section of Chapter 1.

Of the large number of future projects or actions, several projects may be considered as reasonably foreseeable, reasonably well-defined, and having known or potential environmental effects that would add to 2020 effects of Reclamation's proposed water contracting actions. These projects are:

- o new offstream storage projects being studied by Reclamation (Los Vaqueros, Los Banos Grande, Wilcox, or Hungry Hollow),
- o use of wildlife refuges for offstream storage of CVP water,
- o DWR's South Delta Water Management Program,
- o DWR's North Delta Water Management Program,
- o Contra Costa Water District's Los Vaqueros project,
- o Bedford Properties' Delta islands water storage project, and
- o Reclamation's multipurpose Auburn Dam.

Table 5-12 summarizes the possible environmental effects of the above projects when added to the 2020 impacts of Reclamation's proposed contracting actions. It must be emphasized that each of these projects is subject to detailed, project-specific environmental review and mitigation measure development. Mitigation measures for cumulative impacts include safeguards established by federal and state statutes and regulations, provisions in CVP and SWP contracts, physical mitigation measures, and numerous environmental study programs underway that will lead to the development of future mitigation measures.

Table 5-12. Expected Environmental Effects of Future Related Actions

Effects	Actions or Projects						
	New Offstream Storage	Refuge Offstream Storage	South Delta Plans	North Delta Plans	Los Vaqueros Reservoir	Delta Island Water Storage	Auburn Dam
Hydrologic							
Delta Inflow	Potential changes in flow patterns.	No change.	No change.	No change.	No change.	No change.	Potential seasonal changes in flow patterns.
CVP Firm Yield	±260,000 af	±90,000 af	Increase if Corps criteria lifted.	Increase if Corps criteria lifted.	±80,000 af	No change.	±20,000 af
Delta Export	Increase.	Increase.	Increase if Corps criteria lifted.	Increase if Corps criteria lifted.	No change compared to 2020 baseline conditions.	Increase.	Possible increase.
Delta Outflow (Annual)	Decrease.	Decrease.	Decrease if Corps criteria lifted.	Decrease if Corps criteria lifted.	No change compared to 2020 baseline conditions.	Decrease.	Decrease during wet years.
CVP Reservoir Operations	Existing reservoirs could maintain higher levels.	No change.	Possible changes if Corps criteria lifted.	Possible changes if Corps criteria lifted.	No change.	No change.	Changes in Folsom Reservoir operations.
Streamflows (Sacramento and American Rivers)	Little direct effect.	Minor seasonal changes.	Possible changes if Corps criteria lifted.	Possible changes if Corps criteria lifted.	No change.	No change.	Seasonal changes in the lower American River.
Environmental Fisheries							
Riverine	Little direct effect.	Potential adverse effects due to spring river temperature increases.	Possible effects if Corps criteria lifted.	Possible effects if Corps criteria lifted.	No change.	No change.	Adverse upstream effects and beneficial downstream effects.
Delta	Operational flexibility to minimize entrainment losses.	Depends on final plans.	Depends on final plans.	Depends on final plans.	Potential effects.	Operational flexibility to minimize screening losses.	Potential effects.
Bay	Potential effects if bay circulation patterns change.	Potential effects if bay circulation patterns change.	Depends on final plans.	Depends on final plans.	Potential effects.	Potential effects.	Potential effects.
Other	Land use, fish, wildlife, and cultural resource effects caused by project construction and operation and new CVP contracts.	Land use, fish, wildlife, and cultural resource effects caused by project construction and operation and new CVP contracts.	Land use, fish, wildlife, and cultural resource effects caused by project construction and operation and new CVP contracts.	Land use, fish, wildlife, and cultural resource effects caused by project construction and operation and new CVP contracts.	Land use, fish, wildlife, and cultural resource effects caused by project construction and operation and new CVP contracts.	Land use, fish, wildlife, and cultural resource effects caused by project construction and operation and new CVP contracts.	Land use, fish, wildlife, and cultural resource effects caused by project construction and operation and new CVP contracts.